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MARCH 2019

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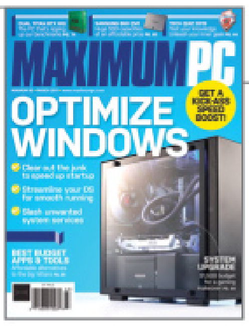

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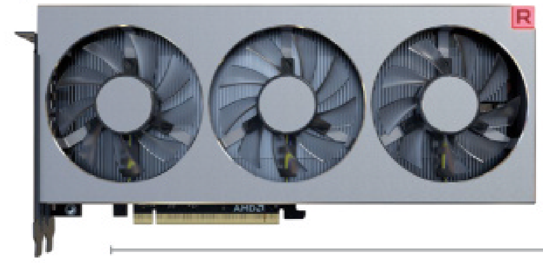

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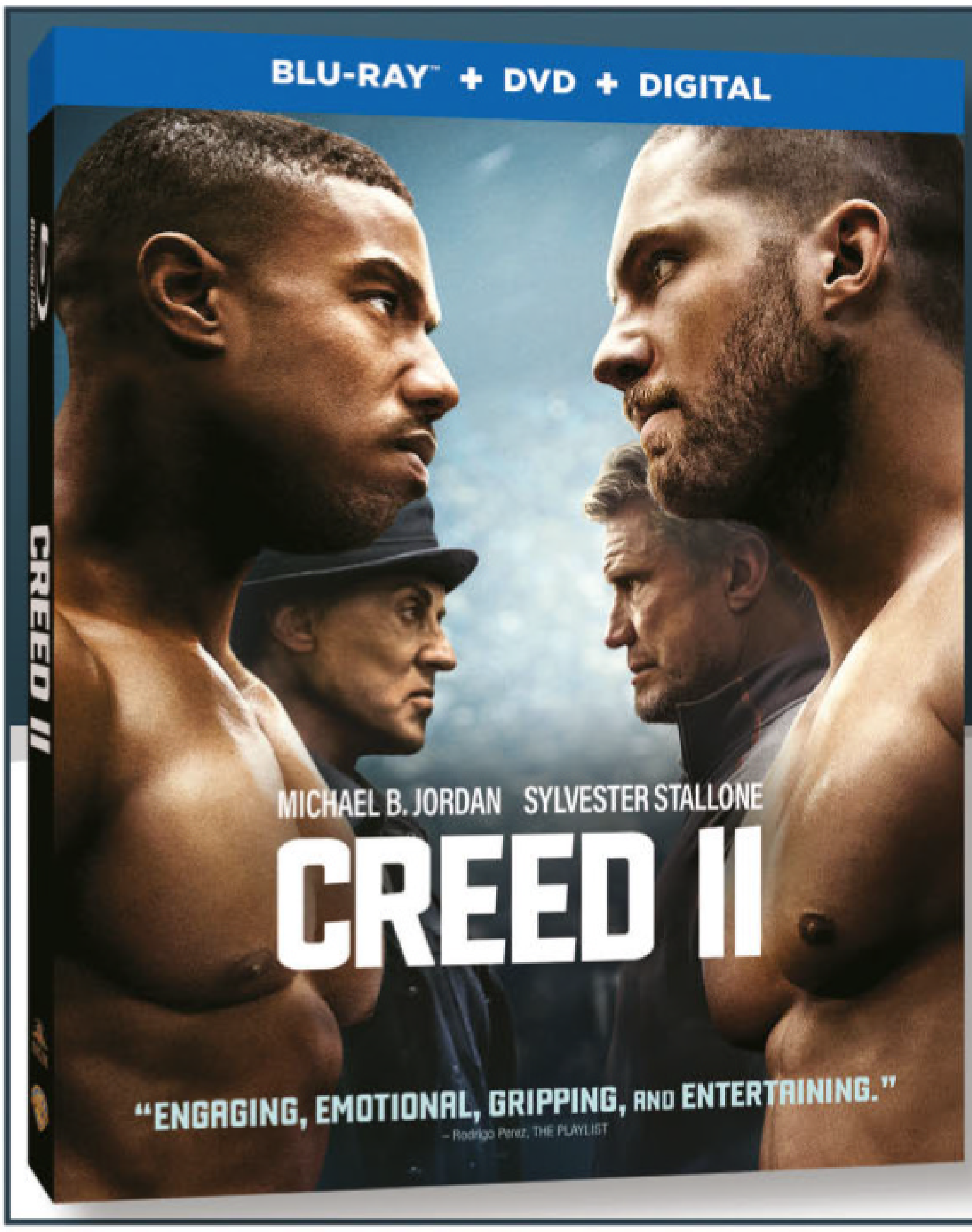
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STOP HOLDING YOUR MACHINE BACK; UNLOCK ITS FULL POTENTIAL

WE LOVE PERFORMANCE on *Maximum PC*. It would be our middle name, if we had one. Whether we're looking at high-end hardware or the latest budget offerings, we want the best performance possible from the components used, often pushing things even harder with a little judicious overclocking to eke out those last few percentage points. There's something plenty of us fall on down, though, and that's on the software front. Specifically, the OS.

If performance is important to you—and given you're reading *Maximum PC*, it probably is—a clean install of Windows is what you really want. Whether you've just installed a new component, or have been rocking the same hardware for a while, cutting out all the detritus and bloat of a well-used operating system can give any machine a new lease of life. Achieving this nirvana isn't easy, though, especially if you're not one to maintain a tight regime of file management and data organization.

We're alluding to how you back up here, basically. How you organize your files, your data, your irreplaceable documents, so that you can wipe your drives and start again. Despite banging on about such things for years, we're well aware that plenty of readers can't simply wipe their current install and start anew. It just isn't always a practical solution. Which is why this issue we show you how to achieve that fresh install vibe, without losing any of your precious data. Turn to page 24 to discover how to give your system a massive performance boost.

One of the major sources of bloat for your operating system comes from the software you use, and as time goes on, the big applications have more and more "features" that you probably don't use. One option is to look at some of the budget alternatives to those big apps that don't necessarily need to sell a new version every year, and instead focus on the essentials. Starting on page 30, we look at the best budget alternatives around right now; although, as ever, if there's a package that you use and want to recommend to your fellow readers, please drop me a line, and I'll be more than happy to share.

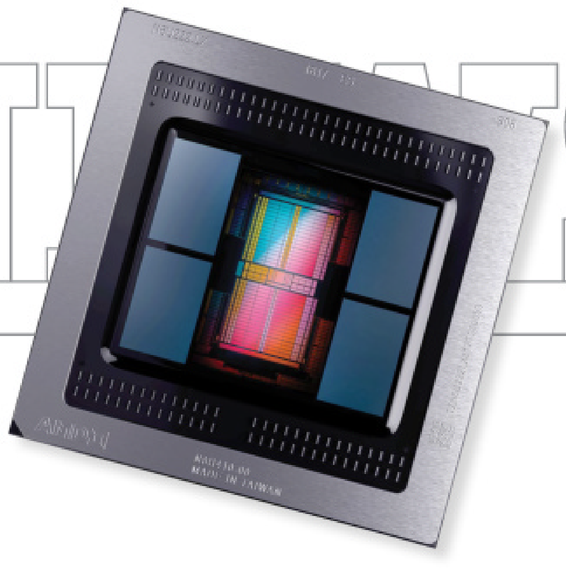
If you've been tempted by the VR bug, but don't want to stump up the cash for the full PC VR experience, then you may be interested by the tutorial on page 56 that shows you how to get Steam VR running on the more affordable Oculus Go (at $250 for the 64GB version, it's a much more palatable way of experiencing virtual worlds). We then go on to look at turning a Raspberry Pi into a Steam Link, so that you can enjoy your games collections from the comfort of your couch.

On top of all that, we also have our quiz of the year for you to sink your teeth into, to discover just how big a geek you really are. Regardless of how well you do, I hope you enjoy the issue.

Alan Dexter is Maximum PC's *executive editor and a punisher of hardware. He's been a tech journalist for over 20 years, and has no problem upsetting the PC industry as a whole.*

↘ submit your questions to: comments@maximumpc.com

THE NEWS



Above: AMD's Radeon VII is aimed squarely at Nvidia's RTX 2080. $699 to you.

First 7nm Gaming GPU Lands

Is the Radeon VII good enough to take the fight to Nvidia?

AFTER MONTHS of focus on Nvidia and its groundbreaking RTX cards, we have a solid response from AMD in the form of the Radeon VII. Unlike the RTX cards, we don't have a fancy new GPU architecture or extra features, but we do get the first consumer outing for the 7nm Vega 20 GPU, which first appeared in November in the Instinct enterprise cards.

The Vega 20 in the Radeon VII has 3,840 stream processors—256 fewer than the Vega 10-powered Vega 64. It carries 60 compute units (four fewer than the enterprise incarnation, and four fewer than the Vega 64). Clock speeds have jumped significantly; the base clock is now 1,400MHz, with a peak boost of 1,750MHz. The die shrink may have lost some cores, but the 200MHz speed bump compensates for that. On paper, the computational power is up by 10 percent.

On the memory side, AMD has packed the Radeon VII with 16GB of high bandwidth memory, HBM2, on a 4,096-bit bus. It has twice the memory on a bus twice as wide as its predecessor, which helps push the headline memory transfer rate from 484GB/s to 1TB/s, faster than is possible with GDDR6. While the GPU might be small—just 331mm^2—it's on a hefty double-width, full-length card, with triple fans. Judging by the two eight-pin power connectors, it'll be burning near 300W at full tilt.

AMD's presentation at CES claimed about a 25 percent performance gain over the Vega 64 on apps such as Adobe Premiere and Blender, helped considerably by that fat memory pipe. On games, it boasted a 35 percent jump for *Battlefield V*, and a 25 percent jump for *Fortnite*. AMD also matched it against the RTX 2080, and claimed almost identical frame rates on *Battlefield V* and *Far Cry 5*.

The Radeon VII will launch at $699, leaving quite a gap between it and the Vega 64, at $400 or so. It's aimed squarely at the RTX 2080, which also starts at $699. The comparison is unavoidable, and all the first benchmarks pit the two against each other. It would appear to be a close-run thing for the most part, too. Next month, we'll bring all the gritty details you could want.

Is it enough? If games are your thing, similar performance for the same money as an 2080 is hardly compelling, as you don't get the RTX ray tracing or AI features (especially that juicy DLSS). That extra 8GB sounds useful, but few games need that much headroom. If you're looking at content creation, things look much more desirable—oodles of fast memory is just what you need. It does have some great tricks, such as strong FP64 performance, which shows its enterprise roots.

AMD has more to come, of course—the all-new Navi architecture is anticipated to surface before the end of the year. It's expected to be aimed at the mass market, including consoles and mobile devices, leaving Vega-powered cards at the top end for now. It's no secret that AMD has been working closely with Sony to get Navi into the PlayStation 5. The next-gen Xbox also looks a likely customer.

Back at Nvidia, we have confirmation of new mid-range Turing-powered cards using TU116 cores. There's the GeForce GTX 1660 Ti with a 1,500MHz base clock, 1,536 CUDA cores, and 6GB of RAM. It's launching at $279. Below this is the GeForce GTX 1660 with 1,280 cores and a slower memory clock, due in March for $230 or so. A 1650 will follow at $180. This fills out the Nvidia range nicely. Being GTX cards, you won't get the fancy extras of the RTX series, but the Turing core will give a useful performance hit. A 1660 Ti is about 20 percent faster than a 1060 in first tests.

Meanwhile, Nvidia CEO Jen-Hsun Huang's response to the Radeon VII has been somewhat tactless. He reportedly called its performance "lousy, and there's nothing new." Harsh, sir. The Nvidia and AMD rivalry over graphic cards is analogous of Intel and AMD's sparring over processors. One side produces the expensive and ultimately faster gear, while the other produces something that can still do most of the heavy lifting you need, but at a more attractive price. Or that used to be the case; AMD has pitched the Radeon VII pretty high. At least we have some competition near the top now, and that is always a good thing. **–CL**

> "While the GPU is small, it's on a hefty double-width, full-length card, with triple fans.

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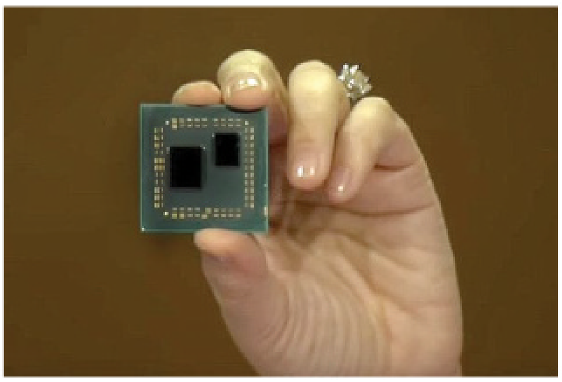

ENTER THE 7nm ZEN 2 CHIPLET

First Ryzen 3 silicon makes an appearance

AMD'S PROCESSOR development schedule continues to run apace. Last spring we saw the arrival of the Zen+ core; this year we'll get the Zen 2 core, and the accompanying 3000 series chips. At CES, we saw our first silicon. The Zen 2 design uses chiplets, in this case an eight-core 7nm processor chiplet, and a 14nm I/O processor on the same substrate. Tellingly, there was room on the chip for another eight-core chiplet. You can even see the traces laid out for it.

AMD is being tight on details, but it did boast that its pre-production chip could run Cinebench with a score of 2,057, which compares well with a Core i9-9900K at 2,042. It did this while drawing 130W, against the Intel's 180W.

There are lots of leaks about Ryzen 3 floating about, of varying veracity. One more reliable source lists an entry-level six-core 3300X running at a base clock of 3.5GHz, through to a 3800X with 16 cores running at 3.9GHz. The same leak also has a 3700X, a 12-core part, hitting the magical 5GHz on boost. Sounds good so far. What's amazing are the quoted TDP figures; even the 16-core monster draws just 125W. All true? Hard to say until it's in our labs.

What we do know are the clock speeds on the engineering samples. We've seen an eight-core chip running at 3.4GHz, with a boost of 3.7GHz, and a 12-core sample at 3.4GHz, with a boost of 3.7GHz. Engineering samples are often run at more pedestrian speeds, so 5GHz is not unrealistic.

The Zen 2 architecture is starting to cause a real buzz. Those little 7nm chiplets are going to be used right across AMD's range, and there's room on the desktop package for 16 cores, at the same sort of TDP as current eight-core chips, plus huge L3 caches, PCIe 4.0, and more. Single-core performance has always been an AMD weak point; Zen 2 looks set to close the gap further. If Zen was a shock for Intel, Zen 2's chiplets look likely to repeat it. **–CL**

GOOGLE TARGETS ADBLOCKING

CHROME TO DISABLE ADBLOCKERS

GOOGLE HAS PROPOSED a change to Chrome that will stop adblockers working. As made public in its Chrome Extensions Manifest v3, it is planning on limiting the webRequest API, and adding a new one that will require that any extension declares to the browser what it can do, and how. It also has a limited number of items that can be filtered. It's all ostensibly in the name of security. If the proposal goes through, your adblocking apps on Chrome will stop blocking, and you'll see the Internet in all its ad-infested glory.

Adblocking has grown rapidly of late. In the US, about 40 percent of laptops and 33 percent of desktops used adblockers in 2017; 2018's figures are expected to be higher. Ads are money, and collecting and selling your data is a fundamental part of online business. Luckily, we have a choice. There are other browsers, specifically the cross-platform Firefox. Google has a choice, too: market share, or a guaranteed audience. **–CL**

FACEBOOK PLATFORMS TO MERGE

Your data to be shared across platforms

FACEBOOK HAS PLANS FOR YOUR DATA: It is to merge Instagram, WhatsApp, and Facebook Messenger behind the scenes so they can share data. They'll still appear to be separate apps, but under the skin there will be one big integrated Facebook social media platform. You'll be able to send messages from one app to another without switching. It will also enable end-to-end encryption on all three. It's all part of a plan instigated by Mr. Zuckerberg to enable each element of Facebook's social media empire to communicate.

The idea has not been without opponents; this project is reportedly why the company lost the founders of WhatsApp and Instagram last year. Some have complained that the integration will mean the more widespread sharing of personal data. WhatsApp, for example, doesn't require the sharing of much personal data, but this coalescence will connect your account to your Facebook profile and its more comprehensive details. The move may also fall foul of data sharing laws, here and abroad, particularly Europe's stricter laws on merging data. This is a big project, though, so it won't happen for a while just yet. **–CL**

Tech Triumphs and Tragedies

A monthly snapshot of what's good and bad in tech

TRIUMPHS

✓ **LARGER HADRON COLLIDER**
CERN looks set to build a new LHC four times the size of the original, with a 62-mile track.

✓ **FLYING TAXI**
Forget self-driving cars, Boeing has just tested its first autonomous flying craft, the PAV (Passenger Air Vehicle).

✓ **MACHINES PLAY BETTER**
Google's DeepMind AI machine has played the world's best *StarCraft* players, and beaten them ten games to one.

TRAGEDIES

✗ **APPLE'S BLACK SCREENS**
The MacBook Pro has a habit of breaking the ribbon cable connecting the screen to the controller; it costs $600 to fix.

✗ **FAKE 5G**
AT&T has been berated by rivals for its 5G service, because it isn't actually 5G.

✗ **DRAGONFLY ON HOLD**
Google's controversial censored search engine project for China has been stopped after China pulls data support.

Windows 10 Update Steals 7GB

Another Windows Update is due shortly, offering mostly bug fixes and minor interface updates. There is really only one new feature worth mentioning, called Sandbox. This is a secure virtual environment to run questionable apps. It opens a isolated desktop, and anything run within it has no access to your system proper, and is deleted when you close Sandbox. It's an excellent idea.

Another thing: You lose 7GB from your boot drive. Windows Update has never been able to accurately check how much space you have free. Nobody wants to risk having their system fall over halfway through an update, so it ropes off 7GB to ensure it has room to maneuver. Why can't it just ascertain the free disk space? This is, it seems, beyond the capabilities of Microsoft, although it can create an entire virtual machine inside the OS. **–CL**

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Another Year of Cheaper SSDs

You may have noticed that SSDs are still getting cheaper, after they halved last year. Predictions for 2019 are that they will get cheaper still. Production of 3D NAND chips is outstripping demand; 64-layer chips are in large-scale production; and the shift to 96-layer is expected to be in full swing by summer. The big fabs are due to be churning out 50,000–100,000 chips a month, with the major players reaching 150,000. This is too much for the market to bear.

The result is bigger drives, and cheaper drives. For example, Western Digital has just launched its new SN750 range of M.2 cards, still running 64-layer chips. There's nothing much new about them, except that the 2TB model is now just $50 more than last year's 1TB one—that's about 25 cents per GB for premium hardware. Cheaper brands are getting temptingly affordable: a 240GB SSD for $30, or 500GB for $60? No trouble. If you haven't gone solid state yet, this year could be the time; it will be months before prices stabilize and bottom out, too. Unfortunately, DRAM prices won't be moving much—there's less competition, and still a healthy demand. **–CL**

Sorry, this is about as interesting as the Ice Lake-U reveal got.

Intel Talks 10nm Again

INTEL'S MOVE to 10nm has been dogged by delays. Last month, we finally learned a little about Sunny Cove, the new 10nm core architecture. This month, we get a little more: Ice Lake-U, the first to go 10nm, will be a mobile chip. It will be four-core and eight-thread, with a TDP of just 15W. We get Generation 11 graphics, and memory bandwidth is in the 50–60GB/s range. There's also Wi-Fi 6 and Thunderbolt 3 over USB-C. We also learn of Lakefield, a hybrid x86, actually a Sunny Cove core coupled with four Tremont Atom cores. The upshot is a device that can draw minuscule amounts of power on standby. It was apparently a request from a manufacturer—we don't know who, or why, yet. And that's it. Looks like we will have to wait even for vague details on the 10nm desktop parts.

Last month, we also reported on Intel's new F-series of chips. These are high-end processors without integrated graphics, which we hoped would be cheaper than the full versions, especially the Core i9-9900KF. It transpires that Intel is selling them for the same price. F-series chips are standard chips where the integrated graphics have failed. There's no problem with this—many i9 buyers aren't ever going to plug a monitor into the board socket—but a few dollars off the price wouldn't have hurt. It shows how the chip shortage is biting, fueled by massive demand for profitable Xeon chips, thanks to the expansion of cloud services worldwide. Intel can't make the 14nm chips fast enough, and its 10nm desktop replacements are a year away or more.

This could be a tough year for Intel, following a not particularly good end to 2018—its last quarter figures weren't impressive. Plans are afoot, though, as the company restructures itself away from the PC market, toward a data-centric one, and invests heavily in fabrication capacity, including Optane and 5G silicon. All well and good, but at its original core business, there's something of a gap emerging. **–CL**

AMAZON'S SPY RING

Who's watching you?

THE RING SECURITY CAMERA is a great idea, and popular. Amazon bought the company last year for $1 billion, and sales have been buoyant. Unfortunately, Ring gave an external research and development team access to the cloud servers holding every video created by Ring devices from everywhere in the world. The R&D team also had a database that gave the customer's physical address. It was at least all in the name of development; the team was working on Ring's facial recognition algorithms. It has a feature called Neighbors, billed as a kind of digital Neighborhood Watch. Only it didn't work very well, and Ring decided to give engineers all their customers' videos to teach the AI systems. Ring also gave US executives and engineers access to live feeds from any camera.

Nowhere on Ring's privacy policy does it warn you that others may have access to the view from your door, or wherever you put the Ring. The IoT is a powerful and wonderful thing, but if you have a camera that can be viewed remotely, there is a chance somebody else can do it too. If it's hackers, that is a risk we have to take, no matter how good the security. For the supplier of your gear to release it without permission, and almost no restrictions, to another party.... Tut. **–CL**

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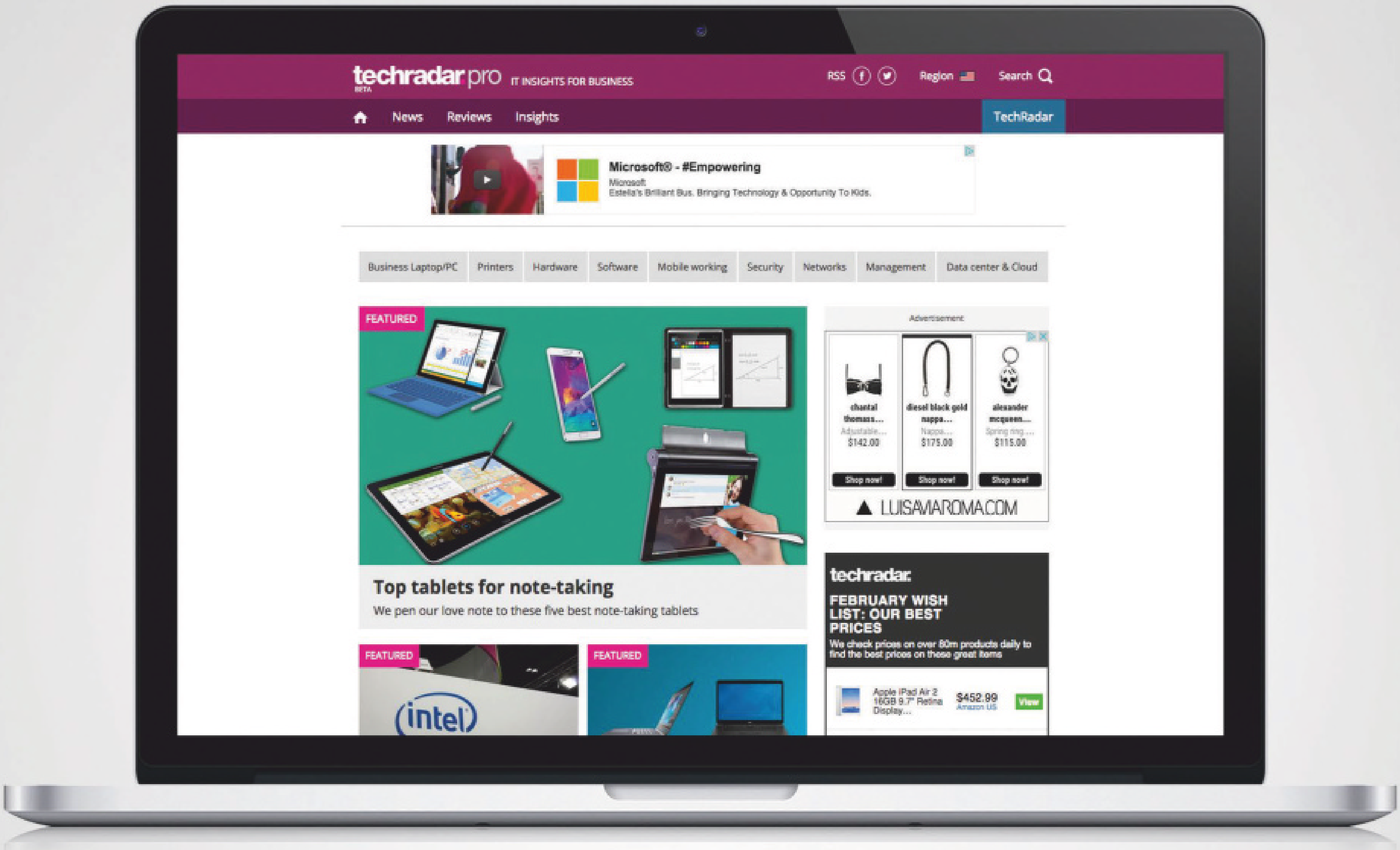
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Jarred Walton

TECH TALK

Radeon VII Is the First 7nm Consumer GPU

THERE HAS BEEN a lot of speculation over when we'd see the first consumer graphics cards built on a 7nm process. AMD launched an updated version of its Vega architecture late last year, shrunk down to 7nm, as the Radeon Instinct MI60 and MI50.

AMD has dramatically altered its reference design with the Radeon VII, with triple fans.

These are professional products built for machine learning and other computational workloads, but would we see anything for gamers built off the chip? It turns out the answer is yes. And soon.

AMD revealed the Radeon VII at CES, with the cards going on sale February 7 at $699. There are multiple tie-ins to the name, it seems: "VII" for "Vega 2" is one, and the Roman numeral for seven hints at the 7nm lithography. It's probably also why AMD selected February 7 for its launch. The Radeon VII is destined to go up against Nvidia's RTX 2080, and AMD claims it will offer comparable performance. That would require a decent boost compared to the existing Vega 64, as my benchmarks have the RTX 2080 leading by 45 percent on average in 1440p and 4K workloads.

AMD improves performance with Radeon VII in several ways. First, it will pack 3,840 stream processing cores, fewer than Vega 64's 4,096, but they'll be clocked at up to 1.75GHz—about 200MHz higher than Vega 64. That's a net improvement in computational performance of about 10 percent, which doesn't seem like much, but there are some architectural improvements as well. Vega 7nm has 13.5 billion transistors, compared to 12.5 on Vega 64, and some of the additional transistors help improve latencies and shader performance.

AMD also doubles down on memory bandwidth, by including four stacks of HBM2, giving it 16GB of VRAM and a massive 1TB/s of bandwidth. We already know Vega scales well with memory bandwidth, and the Radeon VII looks promising for workloads that stress that aspect. Overall, AMD claims it will be about 30 percent better performance on average compared to Vega 64. There are some concerns, however. Even if Radeon VII does deliver "comparable performance" to the RTX 2080, that doesn't include ray-tracing or deep-learning workloads. AMD's stance is that those are both early and expensive features, and it will offer hardware with ray-tracing support when it makes sense to do so. In the meantime, like all other non-RTX GPUs, the Radeon VII will be far slower in DXR games.

Radeon VII also hints at what we can expect from TSMC's 7nm process. It's mostly die shrink (plus about 10 percent more transistors for the above enhancements), and the resulting GPU core is 331mm^2 compared to 495mm^2 for the 12nm version. So, it's not 40 percent smaller, while perfect scaling from 12nm to 7nm would have yielded something closer to 65 percent smaller. The bigger problem remains efficiency, however.

The Radeon VII is a 300W part; basically the same as the Vega 64, and 80W more than the RTX 2080. If we're talking about price and performance parity, that's not good, especially since the RTX includes hardware ray-tracing and deep-learning features. I haven't had a chance to test the Radeon VII yet, but on paper it looks to be a repeat of AMD's last two high-end GPU launches: slower than Nvidia's best, uses more power, lacking some key features, all while being months late to the party. It seems more reasonable to peg the Radeon VII as the AMD alternative to the GTX 1080 Ti, which is nearly two years old.

I suspect the Radeon VII will end up being of only marginal interest to gamers, who will continue to be better served by either Nvidia GPUs or lower priced AMD and Nvidia offerings. However, content creators may find the gobs of memory and bandwidth useful, and it's good AMD at least has an alternative to RTX. But the true test will be Navi, which will likely feature more architectural changes and bring power use in line with Nvidia's GPUs. Unfortunately, with Radeon VII launching in February, it's a stretch for AMD to release a second high-end GPU in 2019. Let's hope I'm wrong, because in 2020, it will likely be going up against a 7nm die shrink and enhancement of Nvidia's Turing architecture.

Jarred Walton has been a PC and gaming enthusiast for over 30 years.

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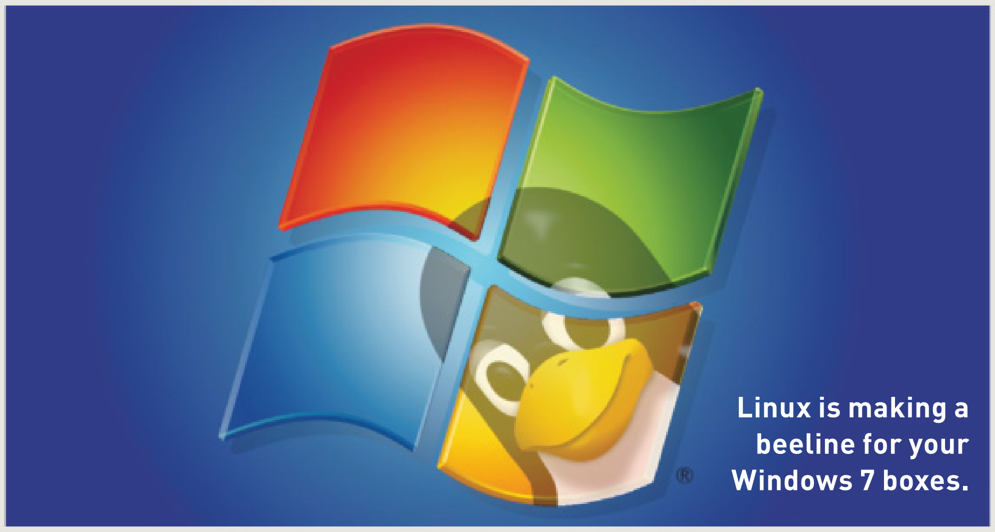
Alex Campbell

OPEN SOURCE

Windows 7's Swansong Is Opportunity for Penguins

WHETHER YOU'RE BUILDING a home server from an old PC or simply breathing new life into a well-loved laptop, there's a good chance that older hardware is still perfectly fine under Linux. Just because Windows 7 is in its final year doesn't mean your PC has to die with it.



Linux is making a beeline for your Windows 7 boxes.

As Windows progresses, older versions fall by the wayside. The latest victim of time's relentless march is Windows 7, which will see the end of extended support on January 14, 2020. This presents three sensible possibilities for a Win 7 machine: retirement and replacement, upgrade to Windows 10, or install and run Linux.

As long as I've been a Linux user, it's been hard to convince people to try—let alone switch to—Linux on a brand-new PC. To be fair, there's good reason not to: Each new Windows version has flashy new features and interfaces. And, usually, everything works as intended out of the box.

Historically, it was rarely smooth sailing for a new Linux install, especially on newer hardware. Some things were quirky or didn't work at all, with wireless networking being the brunt of many a joke about desktop Linux. Nowadays, the vast majority of new hardware works under Linux without a hitch. Sure, you might need a proprietary driver or two—*cough* Nvidia *cough*—but you can be pretty certain that most chipsets and devices will work on Linux at some level of functionality.

Linux is really good at supporting older hardware. For the average user, this means that Linux will generally work really well on old PCs. If you've recently upgraded your main machine over the holidays, and have old hardware lying around, you can keep the old rig out of landfill and get a few more useful years out of it as a backup rig, guest machine, server, or hand-me-down.

One of the primary reasons this is possible is due to how lightweight Linux desktops are. Some of the more feature-rich desktop environments, such as KDE or GNOME, aren't that resource-intensive at idle. However, if your system doesn't have much memory to work with, XFCE remains my go-to for a stable, lightweight desktop that has a reasonable level of visual polish. If you're running a system with less than 4GB of RAM, I'd stick to XFCE, and save the RAM for memory-hungry browsers.

If you do install a distribution that comes with KDE or GNOME by default, there's no reason why you can't install XFCE alongside it as the primary desktop environment, provided you have the storage to spare. If that SSD upgrade is on a smaller inexpensive drive, and you really need the extra gigabytes, you can always uninstall GNOME or KDE.

If you're updating your desktop or laptop with a new SSD (which is always a good upgrade for an old system that uses an HDD for system storage), don't fear: Linux has been playing nice with SSDs since kernel 3.8. (The current stable kernel is 4.20.) As long as you use a modern filesystem—such as ext4, which is the default on most Linux distributions—you'll be fine.

There's no promise that Linux will fit every user's needs, but the fact remains that most users now do a large portion of their work in web browsers. For this purpose, Linux works just fine. There's a few quirks and differences in UI, but by installing Chromium or Firefox in Ubuntu on an old laptop, there's no need to shell out the $100 for a Windows 10 license just to browse Facebook or use Google Drive.

Before retiring that laptop or desktop, take a day and see how Linux works in your use case. You could save yourself a hundred bucks, or at least learn (or teach someone) something new.

Alex Campbell is a Linux geek who enjoys learning about computer security.

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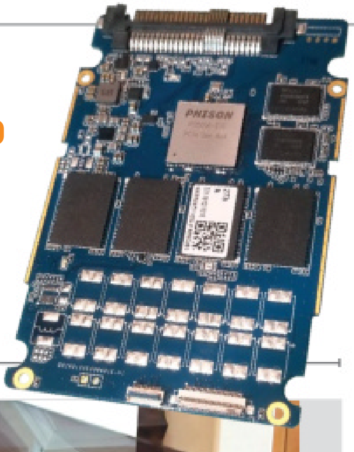
THE LIST

THE BEST TECH OF CES 2019

8 PHISON M.2 PCIE 4.0 X4 SSD

Phison showed off a PCIe 4.0 SSD, clocking in at over 4GB/s sequential reads and writes, hopefully on next-gen AMD motherboards.



7

RAZER TOMAHAWK ELITE CASE

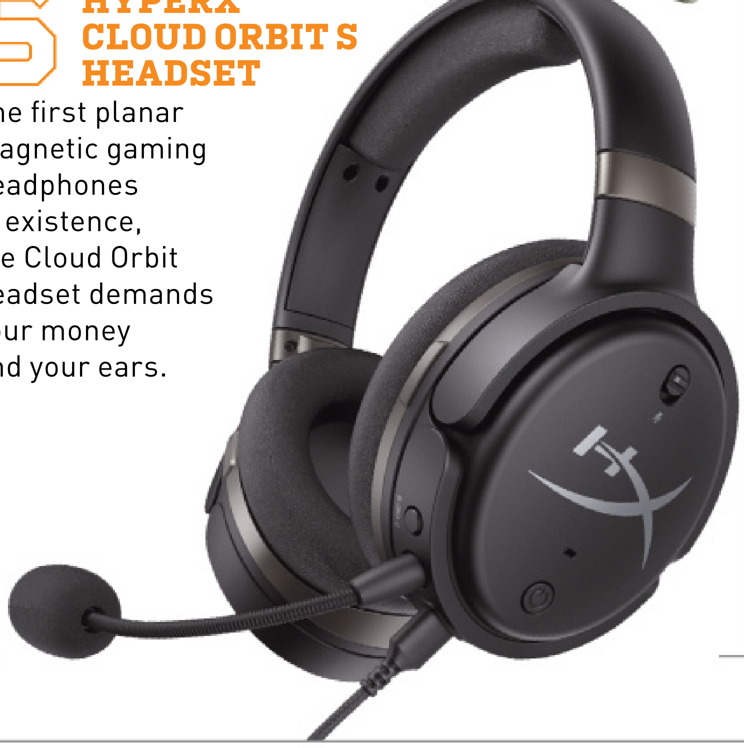
Razer enters the chassis market with this fantastic gullwing-door case. Practical? Hell, no. Do we want it? You bet!

6 ASROCK A300-STX MOTHERBOARD

ASRock's Ryzen-powered A300-STX motherboard comes in at just 5 x 5 inches, and supports integrated GPUs only.

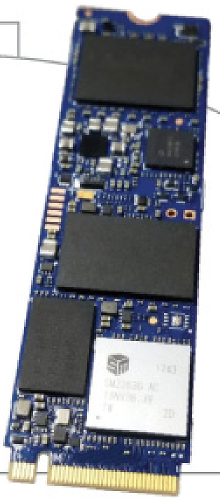
5 HYPERX CLOUD ORBIT S HEADSET

The first planar magnetic gaming headphones in existence, the Cloud Orbit headset demands your money and your ears.



4 INTEL OPTANE H10 M.2 PCIE SSD

Combining a 32GB Optane cache with 1TB of QLC, could this be the year Intel's Optane M.2 drives finally make sense?



3

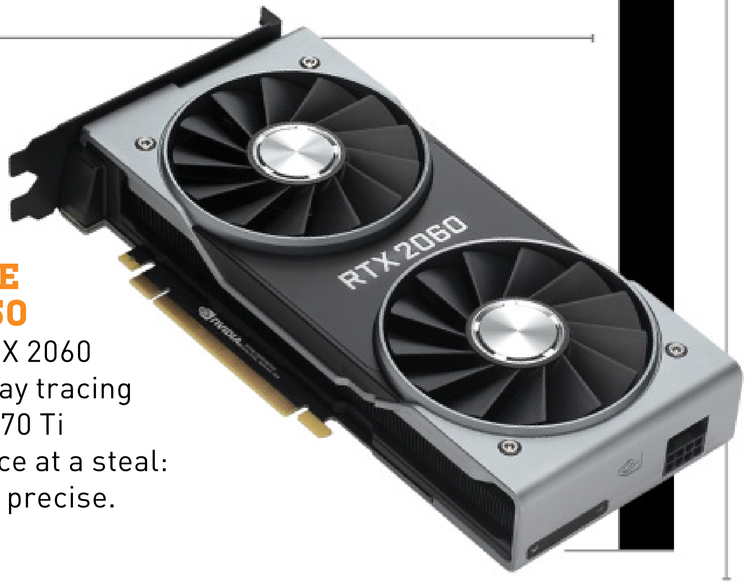
ALIENWARE 4K 55-INCH OLED DISPLAY

This 55-inch 4K screen packs in an OLED panel and 120Hz refresh. If burn-in isn't an issue, it will be king.

2

AMD RADEON VII The world's first 7nm GPU comes as a pumped-up Vega, designed to take on the RTX 2080 at a slightly more affordable price.

1



NVIDIA GEFORCE RTX 2060

Nvidia's RTX 2060 promises ray tracing and GTX 1070 Ti performance at a steal: $350, to be precise.

HEAD TO

BY **JEREMY LAIRD**

Alienware Area 51M vs. Asus ROG Mothership GZ700 vs. Razer Blade 15

Absolute power? Or a nod to portability? Nvidia now bifurcates its mobile GPU offerings, with full performance or so-called Max-Q options, the latter running lower clocks, drawing less power, and squeezing into slimmer systems. A thin-and-light laptop with an Nvidia GeForce RTX 2080? For real. But what makes for the better all-around gaming laptop?

ROUND 1

Portability

Thin-and-light laptops with Max-Q graphics are more portable than desktop replacement monsters. That's a no-brainer. By way of example, the Razer Blade 15 is now available with Nvidia's RTX 2080 mobile GPU, yet measures just 17.8mm thin, and weighs a little over 2kg. The Alienware Area 51M is 42mm at its thickest, and clocks in at nearly 4.5 kilos. The Asus Mothership is a little slimmer at 30mm, but weighs getting on for 5kg. The real question is whether that matters. Does outright performance simply trump portability? If all you care about is performance, the answer is yes. But if that's all you care about, you should have bought a desktop. If you do care about portability, the question is how much, and in what context? The Razer Blade 15 is seriously slim, but would you want it as your daily driver? For us, the answer is yes, but only just. It's on a par with a 15-inch MacBook Pro in that regard. Very portable, rather than ultraportable. As for the other two, the jury is out, mainly because of the Asus's unusual ergonomics. We'll need a little more hands-on time to see if it really offers a superior occasional portability proposition than the Alienware.

Winner:
Razer Blade 15

ROUND 2

Performance

Squeezing a six-core CPU and Nvidia's GeForce RTX into the Razer Blade's slick 15-inch chassis is a marvel of modern engineering, but it does force a few compromises. At best, you're looking at a GPU boost clock of around 1.2GHz. The desktop 2080 hits over 1.7GHz, while the full-fat mobile 2080 in the other two rigs is good for nearly 1.7GHz. Of course, that's with the fans wailing away at full blast. Thermals are at a premium in a thin-and-light, and as dirt and dust builds up, there's a good chance additional clock throttling will set in. As for the two bigger beasts, the Alienware has some obvious advantages. For starters, it runs desktop processors, so you can opt for an eight-core beast. It also has a desktop chipset. On the GPU side, it looks more evenly matched, with it and the Asus offering up to GeForce RTX 2080 graphics. They also offer some serious cooling, even if we suspect the Alienware's thicker chassis will make for superior airflow, despite the Asus's novel vertical design. The Area 51M's dual power supplies also suggest a performance advantage. If your life depended on the highest possible frame rates, you'd pick the Alienware.

Winner:
Alienware Area 51M

ROUND 3

Value

If you're looking for value, you're in the wrong place. Gaming laptops have always looked expensive compared to their desktop siblings. That said, the Razer Blade 15 has by far the lowest starting price, at $1,599. Even fully fitted out with an Nvidia GeForce RTX 2080 GPU, it still comes in just under $3,000. That's a hill of cash—until, that is, you look at the other two. The Alienware Area 51M kicks off at $2,459 with a last-gen GeForce GTX 1070. The cheapest you can get one with a GTX 1080 is $2,999. But that's with a 60Hz display. Add another $200 for 144Hz, which comes as standard with the Razer. As we go to press, Alienware is not listing prices for RTX 2080 models, but we doubt you'll get much change from $4,000. Ouch. As for the Asus Mothership, it comes with a very full-on spec as standard, including a six-core Intel Core i9-8950HK, Nvidia GeForce RTX 2080 graphics, and a 17.3-inch 1080p panel with 144Hz refresh. Asus has yet to price the Mothership up, but given it has positioned the less exotic ROG Zephyrus S 17-inch laptop above $3,500 when configured with an RTX 2080, we suspect a price somewhere in the Alienware's $4,000 ballpark.

Winner:
Razer Blade 15

HEAD

Left to right: Alienware's Area 51M promises GPU upgrades; Asus tears up the rulebook with its ROG Mothership GZ700; the Razer Blade 15 is the most portable.

ROUND 4

Upgradability

On paper, the Alienware Area 51M has the other two hosed when it comes to upgradability. With a standard LGA1151 desktop socket and Z370 chipset, the range of compatible CPUs is the same as any similarly configured desktop. OK, getting at the socket is more involved, and Intel has a habit of breaking backward compatibility, so don't go thinking you'll be able to drop in the latest and greatest CPU four or five years from now. But Alienware has gone to some lengths to optimize the design for upgrades. Tantalizingly, that includes the graphics card, which is built into a new standardized module that's similar to but different from Nvidia's MXM mobile GPU boards of yesteryear. Alienware promises new GPUs will be made available for future drop-in upgrades. The problem is that the graphics module is proprietary, which makes you reliant on Alienware for availability, and also gives plenty of scope for pricing the boards sky high. Time will tell whether Alienware offers timely and affordable GPU upgrades. As for the other two, bar upping the storage and maybe RAM, they are best viewed as non-upgradable. So, it pays to max out your spec from the get-go.

Winner:
Alienware Area 51M

ROUND 5

Gaming Experience

Asus has definitely come up with something novel with the Mothership. With its ability to separate screen and keyboard, while propping the former up on its own, and enabling the latter to fold in half for a solution that looks a lot like a conventional desktop board, the Mothership comes closest to offering a fully flexible desktop experience. It leaves the Alienware looking rather frumpy. Factor in the 17.3-inch 144Hz IPS panel with Nvidia G-Sync, and that RTX 2080 GPU, and you have the makings of what could be the best gaming experience here. The Alienware Area 51M, of course, can hit all those hardware points, but being based on a conventional clamshell chassis, and a very beefy one at that, the Area 51M will never let you forget you're gaming on a laptop. Then there's the relatively diminutive Razer. With its lower GPU clocks, you are not going to get the same frame rates. That said, even at 1.2GHz, an RTX 2080 is a beast of a GPU, and plenty of games are going to fly fast enough to make the most of that 144Hz refresh. There's also a particular pleasure to be had from extracting so much performance from such a slim device.

Winner:
Asus ROG Mothership GZ700

And the Winner Is...

Such are the differences in approach, there can be no objective victor, so what's our personalized pick? We love the look of the new Alienware Area 51M. It promises spectacular performance. And it's great that Alienware is aiming to deliver more upgradability than ever before from a gaming laptop. Problem is, we've heard that before about upgrades for laptops, and it never quite turns out that way. We'd much rather see the emergence of an open standard for mobile GPUs that means you're not reliant on your laptop maker for supply. As for the Asus Mothership, it's intriguing. Time will tell whether it adds up to more or less than the sum of its parts. Even if the answer is more, our money would still go on the Razer Blade 15 and the Nvidia Max-Q approach. Yes, you give up a little gaming performance, but in return you get a lot more of what makes for a great laptop, such as portability and battery life. In other words, the Razer isn't quite as good for gaming, but it's by far the best laptop. And in the end, these are laptops, not desktops.

DOCTOR

THIS MONTH THE DOCTOR TACKLES...

> CPU Compatibility
> Aging Motherboards
> Sound Replacement

Ryzen and Windows 7

Hi Doc. I built a computer for my wife using the following components: an ASRock A320M-HDV motherboard, 8GB of Team Group T-Force DDR4-3000 memory, a Thermaltake Versa H17 case, an AMD Ryzen 3 2200G CPU, and Thermaltake's Smart 430W PSU. I installed Windows 10, ran the system through its paces, and turned it over to her.

The first comment I got was, "Can you give me Windows 7?" She does not like Windows 10, and being a non-technical person, is not persuaded by its superiority over Windows 7. So, I tried to install Win 7 in place of Win 10, but I couldn't do it.

I updated the motherboard's BIOS to version 5.10, dated 2018/10/15, which was the newest available when I checked. I made several different versions of thumb drives and DVDs with Windows 7 and USB drivers, based on the many articles I found online about how to get Windows 7 running on a Ryzen-based PC. None of these worked. The machine crashes at a point just before displaying the Windows 7 logo, and gives me a BSOD. I had no trouble installing Windows 10 from a DVD.

Of course, I don't want to disappoint my wife, and I want her to have a system she's comfortable with. Thus, my questions are: Can Windows 7 work on my Ryzen machine, and if so, what do I need to do? Thanks for your time, attention, and advice.

–Michael Wiplich

THE DOCTOR RESPONDS: Officially, AMD's Ryzen CPUs are not supported by Win 7. Neither are Intel's Kaby Lake (and newer) processors. But as you've seen, workarounds exist that let you add drivers to an offline Windows image or configure the operating system on a donor PC before moving it to your target.

None of those tricks apply to the Ryzen 3 2200G in your wife's PC. AMD's Raven Ridge APUs, which include up to four Zen cores and Radeon Vega graphics, are only supported under Windows 10 64-bit and a couple of Linux distros. Enthusiasts who have tried circumventing this policy report the same thing as you—a stop error before Windows boots to indicate problems with the ACPI.

Rumor has it that certain motherboards running the AMD Generic Encapsulated Software Architecture (AGESA) 1.0.0.6 can be made to install Windows 7. However, you'd still be left without drivers for the on-die graphics engine. The Doc even asked his contact at ASRock for an update on the A320M-HDV, but was only able to confirm that Windows 10 64-bit is the sole compatible Microsoft operating system.

Old Mobo, New Storage

I would like to add a Samsung 970 Pro SSD to my system. I'm currently using an Asus P8Z77-V motherboard. As a result, I'd need to add an adapter, such as the Asus Hyper M.2 X16 interface card. The other PCIe x16 slot hosts a GeForce GTX 1060 graphics card. Would that combination work, or are there better options I should explore?

–Jordan Entz

THE DOCTOR RESPONDS: The Doc does not believe you'd be able to boot from an NVMe-based SSD installed on a Z77 motherboard. At best, you could use the 970 Pro for storage after booting from a more conventional SATA drive.

Samsung's latest would make a great upgrade, but a seven-year-old platform won't utilize it fully. For the sake of cost, compatibility, and comparable performance, a SATA-based 860 Pro would be a great alternative. Or, just put the cash toward a more modern platform.

Future-Proof CPUs

Hello, Doctor. I am about to start shopping for a new Intel-based PC, and I'd like to know which models have

MSI
Eclipse

MSI's Eclipse SLI motherboard was high-end back in its day.

↘ submit your questions to: doctor@maximumpc.com security flaws. Also, can you tell me about other issues affecting the current Intel line-up? **–Larry**

THE DOCTOR RESPONDS: News of vulnerabilities affecting Intel's CPUs broke in January of 2018. As the year went on, additional threats were discovered. They were all related to speculative execution capabilities inherent in the company's architecture, which allow Intel's processors to work ahead on results that may or may not be needed, to improve performance.

Threat Variants 1 and 2, aka Spectre, were addressed via a combination of OS and firmware updates. Variants 3 and 3a, aka Meltdown, were mostly mitigated through firmware updates. Variant 4, listed on Intel's site as Speculative Store Bypass, was patched via firmware and OS code. Firmware also helped stem the effects of L1 Terminal Fault, the fifth variant.

A handful of CPUs include hardware-based solutions to those vulnerabilities. Core i9-9900K, Core i7-9700K, Core i5-9600K, and three mobile chips in the Whiskey Lake family address Variant 3 and Variant 5 without the need for firmware or OS fixes. One of those would be your best bet (for now). The Doc recently purchased a Tiki from Falcon Northwest with a Core i7-9700K, to replace an old Core i7-3770K that suffered slowdowns after applying all of Microsoft's security patches for Windows 10. The speed-up is truly palpable.

Long File Paths

Hi Doc. I'm using the latest version of Windows 10, and I need to go more than 10 places in the file header. It seems that after 10 or 11, I'm not able to access the file, because the location address is too long. Is it possible to override this? **–Tom Adams**

THE DOCTOR RESPONDS: It sounds like you're running into Windows' default maximum path length of 260 characters, which includes the drive letter, colon, backslash, folder names separated by backslashes, and the desired file name. Fortunately, you can get rid of this limitation.

If you're using Windows 10 Pro or Enterprise, open the Group Policy Editor by pressing the Windows key and typing "gpedit.msc." In the left pane, drill down to "Local Computer Policy\Computer Configuration\Administrative Templates\System\Filesystem." On the right-hand side, double-click "Enable Win32 long paths," change "Not Configured" to "Enabled," and press "OK." Alternatively, open the Registry Editor, and navigate to "HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Control\FileSystem." Double-click the DWORD "LongPathsEnabled" and change its value from 0 to 1.

Blown Motherboard?

Hey Doc, I was using my nine-year-old computer when the commercial power went out. It was connected to a Tripp Lite AVR, but no surge protector. Now the system won't even display POST messages. A local repair shop removed the motherboard and connected a known good PSU, CPU, and RAM. It still wouldn't POST. Their conclusion was that the motherboard is bad. My specs include an MSI Eclipse SLI motherboard, an Intel Core i7-965 CPU at 3.2GHz, three 2GB modules of G.Skill DDR3-1333, a pair of MSI N285GTX-T2D1G-OC graphics cards, a Seasonic M12D-850 power supply, and an Antec P182 chassis.

Is my situation hopeless? I do understand that LEDs lighting up doesn't necessarily mean the board is healthy. The LGA 1366 interface is no longer available on new platforms, so if the motherboard is bad, I'll need a new CPU and memory as well, correct? Would I be able to use my

Intel's ninth-gen Core CPUs include hardware mitigations for some vulnerabilities.

video cards? Should I try to save any other components?

I am reluctant to give up. The hard drives are installed in StarTech removable cages, allowing me to run Win XP, Win 7, and Win 10. Newer hardware doesn't support XP, so I'm guessing that legacy software may be lost, too....

I'm not looking for a screaming-fast gaming rig, but high performance in any application is good. Any suggestion would be appreciated. **–Jim Anderson**

THE DOCTOR RESPONDS: Before you do anything drastic, try unplugging the power from your motherboard, removing the board's CR2032 button cell battery, and waiting a few minutes. Reinstall the battery, connect the ATX power cable, and fire your system back up.

If that doesn't work, then yes, you're probably looking at a bad motherboard. Abnormal power conditions can be very hard on voltage regulation circuitry. Given the age of your PSU, the components behind it, and the lack of protection in front of it, a hardware failure isn't surprising.

So long as none of your other components are damaged, you should be able to find a used LGA 1366 motherboard on eBay. Perhaps that would be enough to get you running again. However, the Doc would hesitate to spend money resuscitating such an outdated platform. Modern CPUs and graphics cards are far more efficient, delivering gobs more performance for every watt of power consumption.

And there's no reason to sacrifice your legacy software. Windows 10 includes Hyper-V, a native hypervisor with support for Windows 7, Windows XP Service Pack 3, and many other guest operating systems. If you'd like to play with Hyper-V, press the Windows key, type "optionalfeatures.exe," and hit Enter. Scroll down to "Hyper-V," expand its branch, and check all of the available options. When Windows finishes installing the hypervisor, access the Hyper-V Manager by pressing the Windows key again, typing "Administrative Tools," hitting Enter, and double-clicking the corresponding icon. From there, you're able to create and configure a virtual machine, then point it to install media for your operating system of choice.

Replacing a Classic

Doc, after 12 years of loyal service, my favorite speaker system of all time, the Klipsch ProMedia Ultra 5.1, is finally dying. Unfortunately, it isn't made anymore. I love the setup's sound quality, size, and subwoofer. I was especially fond of its volume control console that allowed me to switch to my headphones with one click.

What does the Doc recommend to replace this legendary setup? **–Erik Figler**

THE DOCTOR RESPONDS: The ProMedia Ultra 5.1 earned enthusiast respect that no speaker system has rivaled. These days, surround setups designed for PCs are exceedingly rare. It's almost like the competition gave up.

In all seriousness, the market for 5.1 speaker systems must be small, given unwieldy cabling and high prices. Logitech's Z906 seems to be the most highly regarded configuration left. Hopefully, it's a suitable substitute for the void left by Klipsch.

OPTIMIZE WINDOWS

Clear out the junk, streamline your OS, and slash unwanted system services

SAMS
Solid Sta

YOUR PC IS A TRAVESTY. It's a mess, and you know it. Files everywhere. Stray registry keys cluttering things up like dust bunnies in the corner of your garage. Unused programs filling your virtual shelves. Hidden auto-running programs under your Desktop's rug. And that's normal, because you're a PC user.

That means you use your PC. In the process, you install things, you juggle files, you toss stuff on the desktop. Sometimes you need to move quickly and messily, sometimes you just can't be bothered. Rest assured, you are doing the right thing. If you spent minutes in meticulous thought every time you had to decide where to save an image or install a piece of software, you'd get nothing done. So, when it's time to clean up, we suggest you do things differently, and stop that mess happening in the first place.

If you've come for the cleaning, don't worry. We'll wade through the numerous methods you could use to scour your PC clean of filth, and do away with the clutter. But there's more to a clean PC than emptying the trash; we're going to seek out the ways you can keep your PC in tip-top super-efficient shape throughout the year. We'll discover methods you can use to get organized without even having to think about it, and software that can make Windows a far more efficient operating system to use.

To continue the by now way overused house-cleaning metaphor, when we're done with your PC, it'll be the difference between your vacuum cleaner being in three distinct parts scattered who-knows-where around your home and having a robot vacuum that empties itself and gives your cat something to fight with. We'll crib from other operating systems, we'll pull in some obscure apps—whatever it takes to turn your PC into a tidy, slick, well-oiled machine that positively encourages you to maintain it.

ASUS
SUNG
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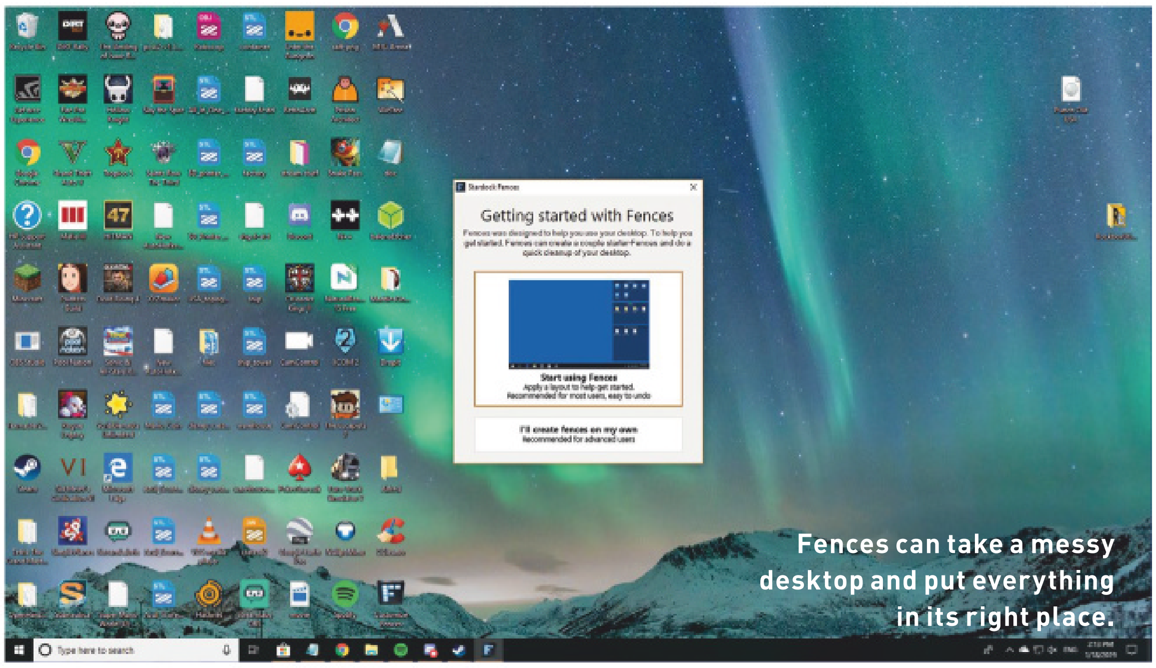
PCIe
NZXT

THROW IT OUT

If you've been a PC user for any length of time, you've likely had a machine start to slow down. So, let's begin by scraping the detritus of a year's use from that drive, freeing up both storage space and, likely, a little memory at the same time. Step one: Head to Windows 10's Settings panel (right-click the "Start" button, and select "Settings"). Click "Apps," sort those apps by install date, and scroll to the bottom of the list. Work your way up, and chip away all those programs you never use by clicking them once, then clicking "Uninstall."



Fences can take a messy desktop and put everything in its right place.

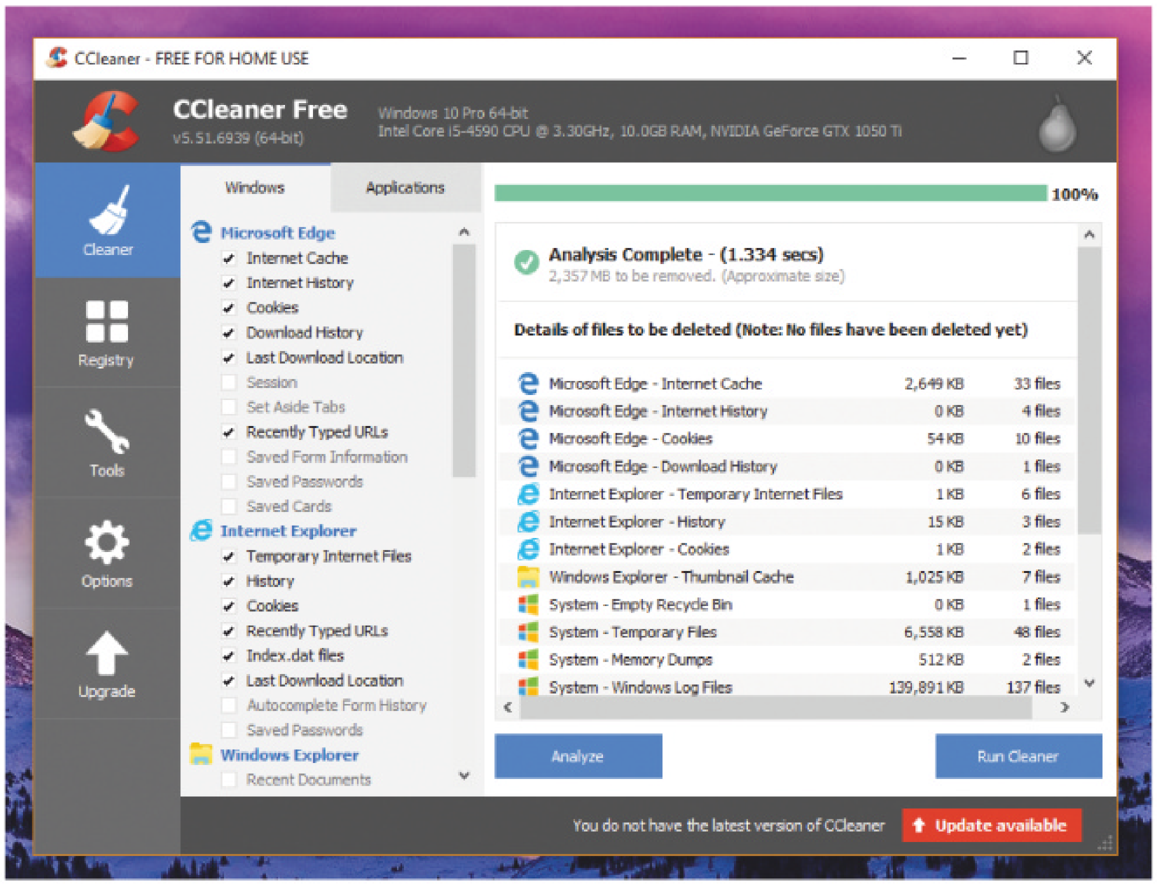
Once you're done with the pretty interface, open the ugly one. Microsoft's doing its best to hide it, but Control Panel is still a thing; start typing its name in the search box, and it'll appear as a result, which you can click to open it up. Head to "Programs → Uninstall a program," and you can sort the list in more logical ways by clicking each column header. Annoyingly, Control Panel doesn't always have the info it needs—half of your software won't have a value listed for size, for example, and the "Last used on" column (if you enable it) doesn't work like it once did.

Now ask your PA to clear your schedule, because you're going to have to put some time and manual labor in. Dig around in the usual suspect folders, and clean out anything you don't absolutely need. Scan your Steam library for barely played games, finally get around to kicking your Downloads folder into check, scrub off those out-of-focus photos. Sift through your Documents folder, and excise the clutter from your desktop—including that "old" folder, and the older "old" folder that's made its way into there. Keep anything you don't want to toss out, but do so on an external drive. Make sure you put these files in properly labeled, well-organized folders, so you can later find them when you need them.

BRING IN THE CLEANER

Time to clear up the digital crumbs that, much like those documents, likely have absolutely no bearing on the performance of your PC whatsoever. This is about being thorough. The recently rebuilt CCleaner is, despite some rather overenthusiastic badgering should you leave it installed when you're done with it, the best free tool for scouring away the cruft. Grab CCleaner Free from www.ccleaner.com, and run through its installer. Run it, then hit "Analyze" to set it sniffing through your drives. You might need to close your web browser—for us, it dug up an unseemly number of Internet cache files, and a few other elements that could save a few gigabytes of space, vital if you're booting from an SSD with limited space available. CCleaner won't delete anything you actually need, but if you're desperate to hang on to those Nvidia installer files, you can wade through the "Windows" and "Applications" tabs, and uncheck anything you'd like to ignore.

Now head to CCleaner's "Registry" page. We're not entering into any major discussion about the benefits of cleaning up your registry; in all likelihood, it's going to make no difference, but hey, let's do it. Click "Scan for Issues," let it shuffle through your mess of a registry, then glance through the list—as with the main Cleaner portion, you're likely to have no issues scraping away the things CCleaner suggests, but you may wish to disable deletions you think might cause problems before you run it. If you're really paranoid, take a backup of your registry first: Run "regedit" via the search box, and use "File → Export" to write it to its own file.



v5.51.6939 (64-bit)
Windows 10 Pro 64-bit
Intel Core i5-4590 CPU @ 3.30GHz, 10.0GB RAM, NVIDIA GeForce GTX 1050 Ti

Microsoft Edge
☑ Internet Cache
☑ Internet History
☑ Cookies
☑ Download History
☑ Last Download Location
☐ Session
☐ Set Aside Tabs
☑ Recently Typed URLs
☐ Saved Form Information
☐ Saved Passwords
☐ Saved Cards

Internet Explorer
☑ Temporary Internet Files
☑ History
☑ Cookies
☑ Recently Typed URLs
☑ Index.dat files
☑ Last Download Location
☐ Autocomplete Form History
☐ Saved Passwords

Windows Explorer
☐ Recent Documents

100%

Analysis Complete - (1.334 secs)
2,357 MB to be removed. (Approximate size)

Details of files to be deleted (Note: No files have been deleted yet)

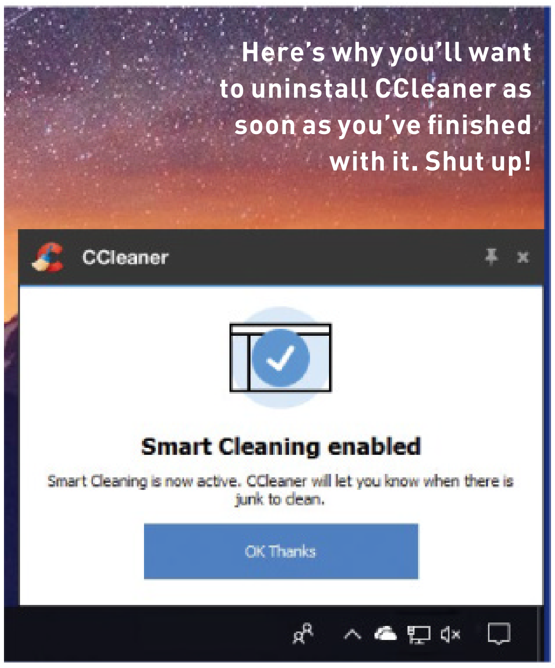
Microsoft Edge - Internet Cache	2,649 KB	33 files
Microsoft Edge - Internet History	0 KB	4 files
Microsoft Edge - Cookies	54 KB	10 files
Microsoft Edge - Download History	0 KB	1 files
Internet Explorer - Temporary Internet Files	1 KB	6 files
Internet Explorer - History	15 KB	3 files
Internet Explorer - Cookies	1 KB	2 files
Windows Explorer - Thumbnail Cache	1,025 KB	7 files
System - Empty Recycle Bin	0 KB	1 files
System - Temporary Files	6,558 KB	48 files
System - Memory Dumps	512 KB	2 files
System - Windows Log Files	139,891 KB	137 files

You do not have the latest version of CCleaner

CCleaner will dig up a host of zeros and ones that would be better off just being zeros.

CLEAN YOUR DESK

It pays to be at least a little agnostic with regard to computing platforms. Linux has its upsides, and we can look at macOS and see some good



Smart Cleaning enabled

Smart Cleaning is now active. CCleaner will let you know when there is junk to clean.

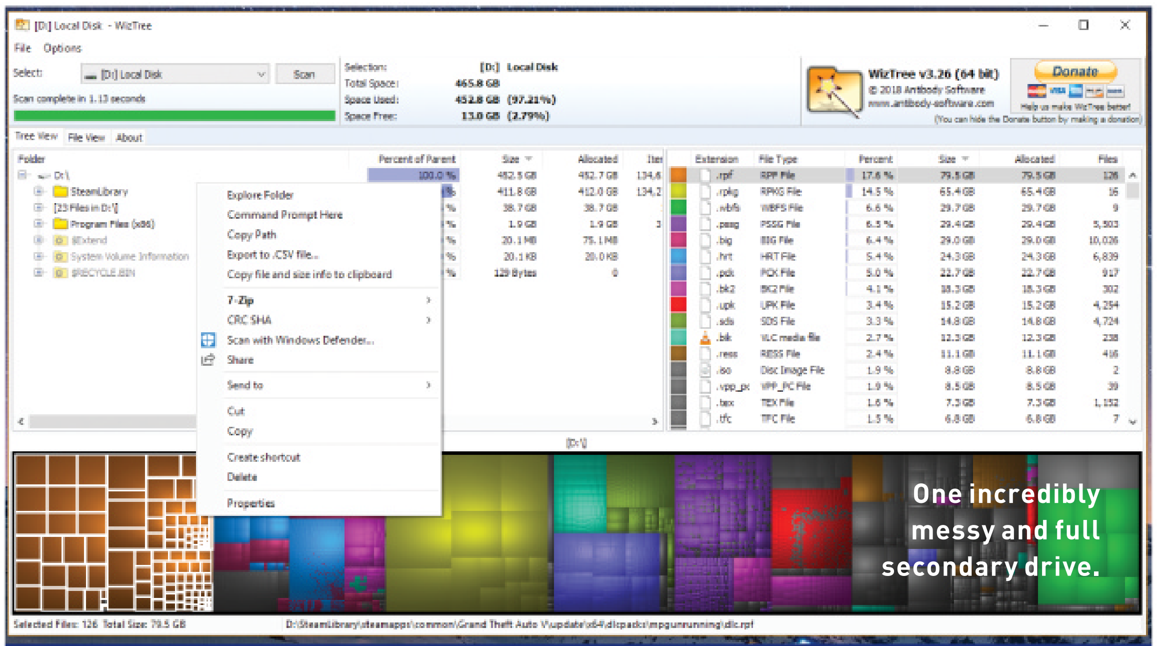
Here's why you'll want to uninstall CCleaner as soon as you've finished with it. Shut up!

in it—particularly when it comes to organizing files. Throw a bunch of things on the macOS Mojave desktop, for example, and you can ask it to pile those files into stacks, which are automatically sorted collections of files of the same type. Stardock, perennial provider of Windows tweaks, produces a tool that can do a very similar thing in the form of Fences, a $10 app with a 30-day free trial. Download it from www.stardock.com (use the "Try It Free" link), and install it—be sure to disable also installing Groupy during the process. Hit "Start 30 Day Trial," and give Stardock an email address. If you'd rather keep your inbox clean while we're on this kick, you may wish to head to http://temp-mail.org to generate a burner email address there to verify your account.

Hit "Start using Fences." It will pull your desktop's files into some kind of order automatically. Creating a new fence is just a case of dragging a box on your desktop; check the "Sorting and Organizing" section of the Fences interface to see how you can automatically shuffle individual file types into their pens. You may also wish to invest in Stardock's $30 Object Desktop package, which bundles Fences with Groupy (organize apps into tabbed groups), SpaceMonger (manage hard disk space to free it up), and a host of frivolous visual "improvements" that you don't need. If you don't want to pay, the free Nimi Places (http://mynimi.net) does most of the things Fences does without the same level of customization or flair.

YOU LACK DISCIPLINE

You are the reason your PC is in the state it's in. Although you can get away with the kind of



[D:] Local Disk - WizTree

Scan complete in 1.13 seconds

Selection: [D:] Local Disk
Total Space: 465.8 GB
Space Used: 452.8 GB (97.21%)
Space Free: 13.0 GB (2.79%)

WizTree v3.26 (64 bit)
© 2018 Antibody Software
www.antibody-software.com

Folder	Percent of Parent	Size	Allocated	Iter
D:\	100.0 %	452.5 GB	452.7 GB	134,6
SteamLibrary	%	411.8 GB	412.0 GB	134,2
[23 Files in D:\]	%	38.7 GB	38.7 GB	
Program Files (x86)	%	1.9 GB	1.9 GB	3
$Extend	%	20.1 MB	75.1 MB	
System Volume Information	%	20.1 KB	20.0 KB	
$RECYCLE.BIN	%	129 Bytes	0	

Extension	File Type	Percent	Size	Allocated	Files
.rpf	RPF File	17.6 %	79.5 GB	79.5 GB	126
.rpkg	RPKG File	14.5 %	65.4 GB	65.4 GB	16
.wbfs	WBFS File	6.6 %	29.7 GB	29.7 GB	9
.pssg	PSSG File	6.5 %	29.4 GB	29.4 GB	5,503
.big	BIG File	6.4 %	29.0 GB	29.0 GB	10,026
.hrt	HRT File	5.4 %	24.3 GB	24.3 GB	6,839
.pck	PCK File	5.0 %	22.7 GB	22.7 GB	917
.bk2	BK2 File	4.1 %	18.3 GB	18.3 GB	302
.upk	UPK File	3.4 %	15.2 GB	15.2 GB	4,254
.sds	SDS File	3.3 %	14.8 GB	14.8 GB	4,724
.bik	VLC media file	2.7 %	12.3 GB	12.3 GB	238
.ress	RESS File	2.4 %	11.1 GB	11.1 GB	416
.iso	Disc Image File	1.9 %	8.8 GB	8.8 GB	2
.vpp_pc	VPP_PC File	1.9 %	8.5 GB	8.5 GB	39
.tex	TEX File	1.6 %	7.3 GB	7.3 GB	1,152
.tfc	TFC File	1.5 %	6.8 GB	6.8 GB	7

Selected Files: 126 Total Size: 79.5 GB

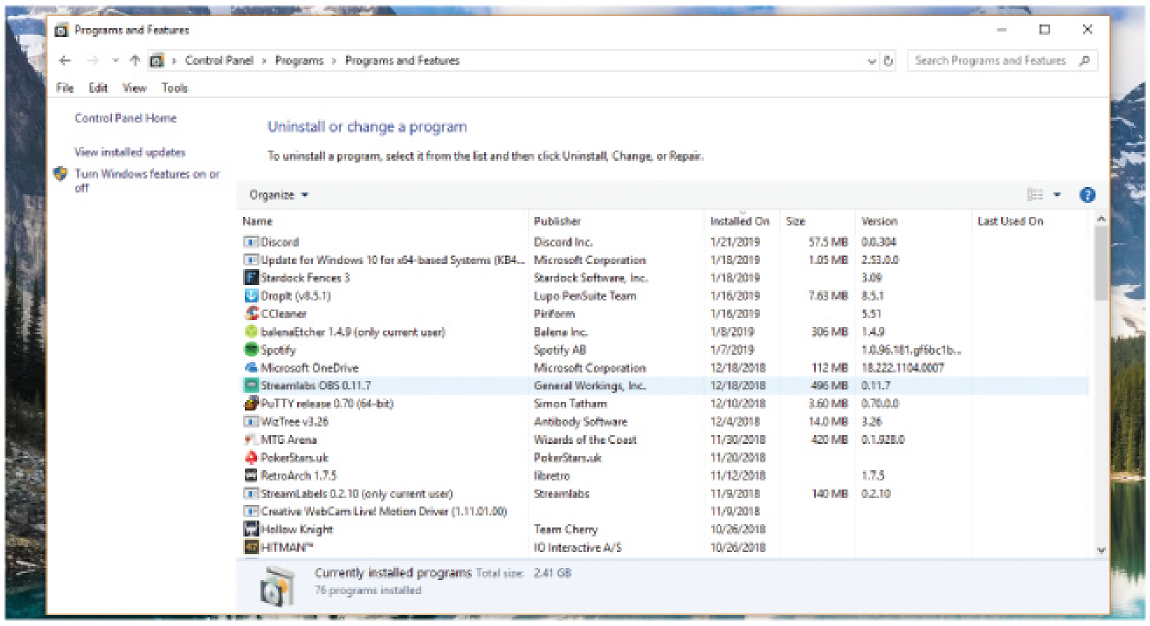
D:\SteamLibrary\steamapps\common\Grand Theft Auto V\update\x64\dlcpacks\mpgunrunning\dlc.rpf

One incredibly messy and full secondary drive.

WHAT'S ON MY DRIVE?

There is (usually) no good reason to keep your main drive full of massive files. While the performance benefits only really start to show when you clear off a nigh-completely full drive, we've already discussed the fact that your main drive is not a trash can. You really should clean that thing up. To find the biggest files, a visual tool is a far better choice than a manual deep dive; while we'd have once recommended WinDirStat (http://windirstat.net)—and, honestly, it's still an awesome tool—we've recently come across WizTree (http://antibody-software.com), which is an astonishingly fast way of doing the exact same thing, and the best way to scan your drive to see precisely what's taking up all that space.

Run it, select a drive, and you're given a whole swathe of stats in the top two panels, and a colored map in the lower one, with bigger squares representing larger files, and each color and shading gradient grouping those files together in their constituent folders. Scan your mouse over the colored map to see details on those files; right-clicking gives you a context menu with the option to head to the folder to see what's up, or do all the things you'd normally do in a Windows Explorer right-click context menu, down to deleting those files right there and then. Pay special attention to the top-right pane, as it can offer some insight about the kind of files that are the biggest menace; if you've been going Linux distro happy, for example, and happen to have a drive full of enormous ISO files, you'll be able to quickly expand the tree to chip away at them—their actual location on the drive doesn't matter at all.


Control Panel > Programs > Programs and Features
Search Programs and Features
File
Edit
View
Tools
Control Panel Home
View installed updates
Turn Windows features on or off
Organize

Programs and Features

Uninstall or change a program

To uninstall a program, select it from the list and then click Uninstall, Change, or Repair.

Name	Publisher	Installed On	Size	Version	Last Used On
Discord	Discord Inc.	1/21/2019	57.5 MB	0.0.304	
Update for Windows 10 for x64-based Systems (KB4...	Microsoft Corporation	1/18/2019	1.05 MB	2.53.0.0	
Stardock Fences 3	Stardock Software, Inc.	1/18/2019		3.09	
Dropit (v8.5.1)	Lupo PenSuite Team	1/16/2019	7.63 MB	8.5.1	
CCleaner	Piriform	1/16/2019		5.51	
balenaEtcher 1.4.9 (only current user)	Balena Inc.	1/8/2019	306 MB	1.4.9	
Spotify	Spotify AB	1/7/2019		1.0.96.181.gf6bc1b...	
Microsoft OneDrive	Microsoft Corporation	12/18/2018	112 MB	18.222.1104.0007	
Streamlabs OBS 0.11.7	General Workings, Inc.	12/18/2018	496 MB	0.11.7	
PuTTY release 0.70 (64-bit)	Simon Tatham	12/10/2018	3.60 MB	0.70.0.0	
WizTree v3.26	Antibody Software	12/4/2018	14.0 MB	3.26	
MTG Arena	Wizards of the Coast	11/30/2018	420 MB	0.1.928.0	
PokerStars.uk	PokerStars.uk	11/20/2018			
RetroArch 1.7.5	libretro	11/12/2018		1.7.5	
StreamLabels 0.2.10 (only current user)	Streamlabs	11/9/2018	140 MB	0.2.10	
Creative WebCam Live! Motion Driver (1.11.01.00)		11/9/2018			
Hollow Knight	Team Cherry	10/26/2018			
HITMAN™	IO Interactive A/S	10/26/2018			

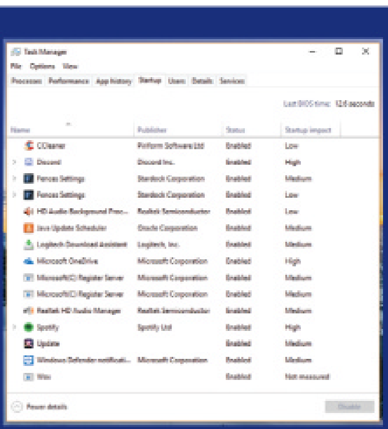
Currently installed programs Total size: 2.41 GB
76 programs installed

Programs are the enemy. Uninstall them. Uninstall them all.

AUTOMATIC FOR THE PEOPLE

You know the most annoying area of clutter on most PCs? The taskbar. More specifically, the notification area. There's a lot in there that tries to hide itself, but clicking the up arrow icon will likely reveal a bunch of software that's running without doing anything useful. We're not suggesting you dump your antivirus (though Windows Defender is now very good indeed, so consider whether you need to give up the resources to anything else), and we'll give a pass to certain hardware drivers that make our keyboards do cool things. The rest, though, can probably go.

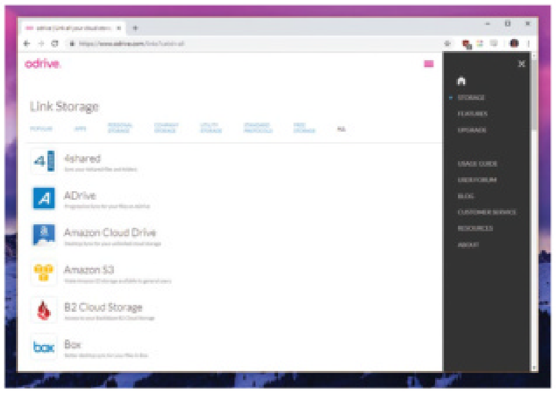
The quickest and easiest way to kill programs that start automatically—and this isn't limited to notification area apps—is to open Task Manager with Ctrl-Shift-Esc, and head to the "Startup" tab. The list here gives an indication of how slow Windows thinks each program is when it comes to affecting your boot time, so click the header to list everything by "Startup Impact," and go to work: Click the items you don't want, hit "Disable," and run those apps manually when you want to use them. For more granular control over what runs when Windows does, download Autoruns from http://sysinternals.com. You can use it to also disable internal Windows components. By all means experiment, but bear in mind that we can't be held responsible if you chop something critical, and that its results can often be as negative as they are positive.



Let's be honest—when did you last use half of this stuff?

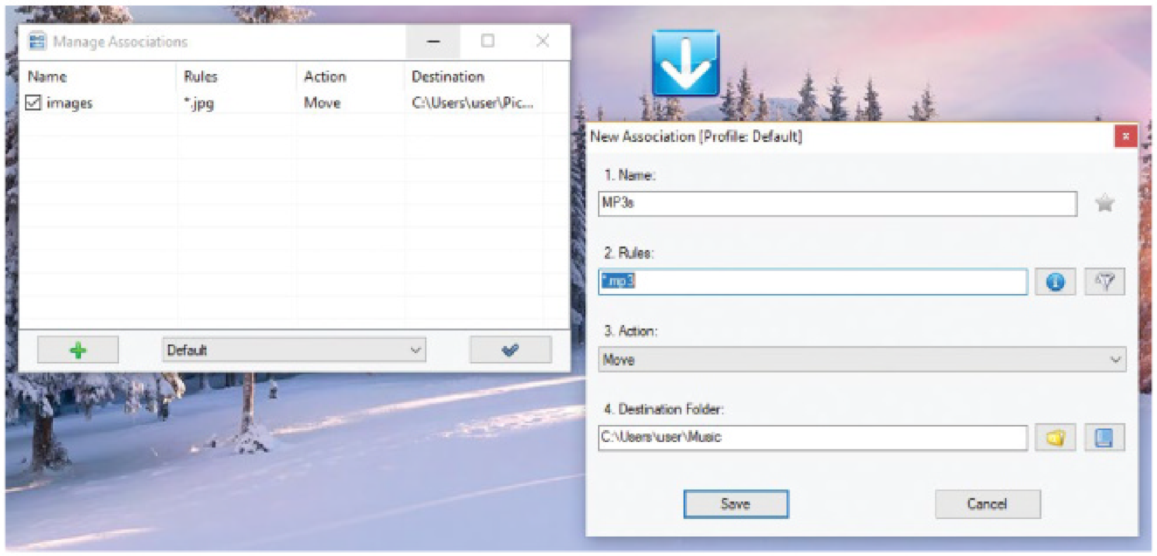
virtual file shuffling that Fences et al pull off, that doesn't help you find what you need when you need it. That's going to be down to you changing your processes as much as possible. We'd start with getting used to throwing things to cloud storage, to ensure those files are available wherever you might need them, and crucially that they're cluttering up a drive somewhere in the ether rather than filling up your own bits. Microsoft's keen for you to use its own cloud service, OneDrive, so we'd probably start there; if you're signed in to Windows 10 with a Microsoft account, you'll already be connected up and ready to go. The basic plan includes a reasonable 5GB storage—not enough for a media library (and nor should you consider using cloud storage for such a thing), but enough for your documents and a good selection of photos.

A link to OneDrive should already be in your Windows Explorer sidebar. When you come to save a file, just expand this, and drop it in one of the folders within. Too much effort? Make a new folder within your OneDrive, er, drive, with an appropriate label. Drag that folder up into the "quick access" portion of the Explorer sidebar, and drop it somewhere prominent. Now it takes just one click, or one drag and drop effort, to save whatever you're saving wherever it should go.



ODrive can link up to 25 different cloud storage services at one time—eight of which are completely free.

If 5GB isn't enough for you, it's either time to pony up for Office 365 (which grants you 1TB of OneDrive storage, with caveats) or sign up to more cloud storage services and repeat the process. Google Drive offers 15GB, and creates itself a neat mirrored folder on your machine, which you can use in the same way as you would OneDrive, and also includes unlimited photo storage at a reduced (but more limited) resolution. Box (www.box.com) dishes up 10GB, with the same structure—although for both Box and Google Drive, you'll need to install an app if you want desktop integration, which (depending on your viewpoint) might go against what we're trying to do here. Assign one file type to one storage medium, one to another, and continue until everything's shipshape.



Name	Rules	Action	Destination
☑ images	*.jpg	Move	C:\Users\user\Pic...

New Association (Profile: Default)

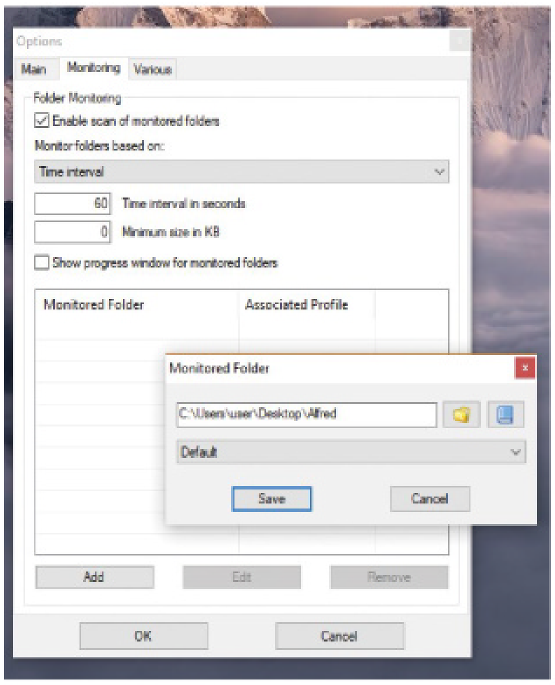
1. Name: MP3s
2. Rules: *.mp3
3. Action: Move
4. Destination Folder: C:\Users\user\Music

Setting up the correct rules will mean your files get sorted into the right place with ease.

Or do away with all the juggling: ODrive (www.odrive.com) enables you to combine storage from a whole host of different cloud providers into one seemingly contiguous online drive. Don't worry too much about the premium features, which you'll lose after seven days, because there's not an awful lot there that'll affect your storage habits. Worry slightly more about the number of permissions you'll need to give up to use it, which basically amounts to read and write access to your whole cloud storage repertoire. If you're signing up, do so (at least) through a Google signup, which uses two-step authentication, and tread carefully.

THE SORTING MACHINE

If you've gotten this far, we're going to presume you're even lazier than we thought. Good news: We have the solution. DropIt (http://dropitproject.com) is presented as a



Folder Monitoring

☑ Enable scan of monitored folders

Monitor folders based on: Time interval

60 Time interval in seconds

0 Minimum size in KB

☐ Show progress window for monitored folders

Monitored Folder	Associated Profile

Monitored Folder

C:\Users\user\Desktop\Alfred

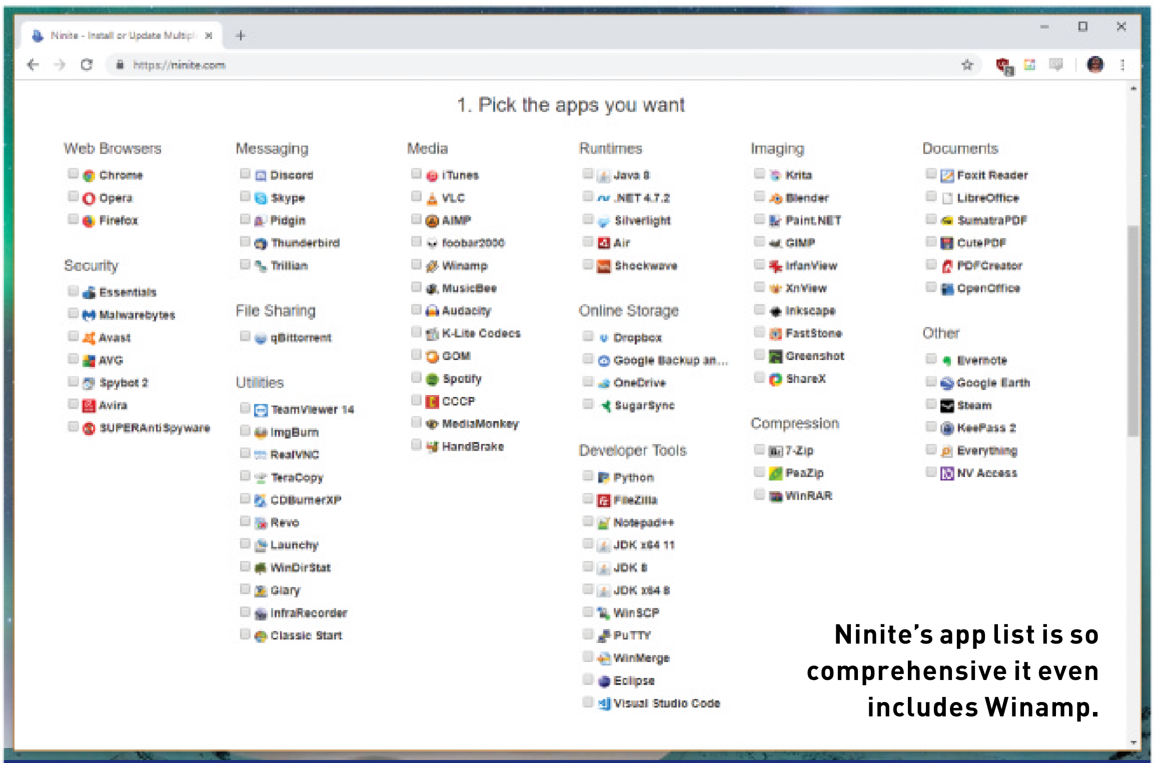
Default

Dump everything in your DropIt folder. You have our permission.

personal assistant for your files, and it makes sorting a large number of them tremendously easy. Set up a number of rules, and you can dump all your files on to the app's icon, at which point DropIt will do the tedious work of putting them in the right place. It's not just a mover—you can use it to split files, compress them, upload them to an FTP or SFTP server, or even generate fancypants galleries or indexes of your files, so you can find them easily later on if Windows Explorer somehow crumbles to dust and ceases to exist.

Most usefully, you can set DropIt to scan a folder and automatically apply its rules to the contents. Let's do that now. Download the installer package from the DropIt site (it's also available in portable form, so you could conceivably create a USB-based housekeeper to send around your home PC collection), and run through the install procedure, selecting the option to launch DropIt on the final screen. This launches DropIt in the form of an always-on-top icon, on to which you can dump your files; double-clicking it puts the icon in your taskbar, so it's less intrusive.

Right-click that DropIt icon, head to "Options," open the "Monitoring" tab, then check the "Enable scan of monitored folders" box. Click "Add" followed by the little yellow folder icon—create yourself a folder (we called ours "Alfred"), drag it to your quick launch bar, and hit "Select Folder." You can select from a bunch of profiles—basically, the rule collections DropIt uses to determine what to do with your files—in the drop-down box, but leave it on "Default" for now, and hit "Save." Now to set a rule for that folder to follow. Right-click the DropIt icon again, and select "Associations." It should automatically open up at the "Default" profile; let's do something simple as an example, such as filtering out common image files, and dumping them in Windows' own Pictures library. Name your rule "images" and in the rules box enter `*.jpg;*.png;*.bmp` and so on for all your favored image types. Set the action as "move" (you could choose "copy" if you were a masochistic file hoarder), and use the "Destination Folder" box to select the appropriate location. Hit "Save," and you're done—any images you drop in the folder will now, once a minute, be piped to the new location. Add another rule for files matching * (that is, any file), and send them to another folder for manual sorting. DropIt runs through the list in order, with the uppermost rules triggering first, so if you later want to sort a different file type (or use the funnel button to add additional filters, such as file size), make sure it appears before the catch-all at the end. ⏻



1. Pick the apps you want

Web Browsers
☐ Chrome
☐ Opera
☐ Firefox

Security
☐ Essentials
☐ Malwarebytes
☐ Avast
☐ AVG
☐ Spybot 2
☐ Avira
☐ SUPERAntiSpyware

Messaging
☐ Discord
☐ Skype
☐ Pidgin
☐ Thunderbird
☐ Trillian

File Sharing
☐ qBittorrent

Utilities
☐ TeamViewer 14
☐ ImgBurn
☐ RealVNC
☐ TeraCopy
☐ CDBurnerXP
☐ Revo
☐ Launchy
☐ WinDirStat
☐ Glary
☐ InfraRecorder
☐ Classic Start

Media
☐ iTunes
☐ VLC
☐ AIMP
☐ foobar2000
☐ Winamp
☐ MusicBee
☐ Audacity
☐ K-Lite Codecs
☐ GOM
☐ Spotify
☐ CCCP
☐ MediaMonkey
☐ HandBrake

Runtimes
☐ Java 8
☐ .NET 4.7.2
☐ Silverlight
☐ Air
☐ Shockwave

Online Storage
☐ Dropbox
☐ Google Backup an...
☐ OneDrive
☐ SugarSync

Developer Tools
☐ Python
☐ FileZilla
☐ Notepad++
☐ JDK x64 11
☐ JDK 8
☐ JDK x64 8
☐ WinSCP
☐ PuTTY
☐ WinMerge
☐ Eclipse
☐ Visual Studio Code

Imaging
☐ Krita
☐ Blender
☐ Paint.NET
☐ GIMP
☐ IrfanView
☐ XnView
☐ Inkscape
☐ FastStone
☐ Greenshot
☐ ShareX

Compression
☐ 7-Zip
☐ PeaZip
☐ WinRAR

Documents
☐ Foxit Reader
☐ LibreOffice
☐ SumatraPDF
☐ CutePDF
☐ PDFCreator
☐ OpenOffice

Other
☐ Evernote
☐ Google Earth
☐ Steam
☐ KeePass 2
☐ Everything
☐ NV Access

Ninite's app list is so comprehensive it even includes Winamp.

MANAGE SOFTWARE INSTALLATIONS BETTER

Windows' own uninstallation options don't always get everything. You've probably heard of the PC Decrapifier, so you may have thought about using it as a hard drive mop. It's certainly worth a shot, and it's likely to catch a few things in its net, but realistically, it's better suited to removing the shovelware packaged with new PCs, rather than uncrusting a venerable old box. The "Tools" menu of the similarly perennial CCleaner, which we've talked about elsewhere, spots a lot more than Windows' default uninstallation efforts—including, mercifully, that preinstalled software that Microsoft tries to force on you, and refuses to acknowledge. Goodbye, Groove Music! See ya, Weather!

If you're going to manage your installations properly, perhaps taking a little inspiration from Linux is in order? Chocolatey (www.chocolatey.org) is certainly one way to do it, downloading new packages and anything they depend upon from servers, and deleting them cleanly when done, although it's complex and finicky, so we don't necessarily recommend it. But aside from the Windows Store, which we can't in good conscience recommend, there's no Steam-style software management tool out there for your desktop apps. Consider, though, the quite excellent Ninite (http://ninite.com), which can help you install a whole bunch of highly useful apps at one time from a selection of the best freeware going, automatically dodging any advertising tack-ons or unwanted features. Click a bunch of boxes on the site, download your installer, and go. Once they're installed, you can rerun your custom Ninite installer to keep your app selection tip-top and squeaky clean by updating them to the latest versions.

msi
steelseries

You don't have to pay top prices for your software.

ALTERNATIVE POWER

You don't have to buy the market leader to get the tools you need. Ian Evenden looks at the world of budget software

WE'VE ALL BEEN THERE. You finish your PC build, it POSTs first time, you install Windows, then what? You use Edge to download Chrome, install some drivers and RGB lighting apps, but you can't do much without software, and apps can be expensive.

There is free software, of course, and some of it is excellent, but there's also a thriving ecosystem of budget apps that are supported on more than a whim, and can be relied on for updates, bug fixes, and extra features. Even the paid-for versions of free apps are worth checking out, as they often offer premium features.

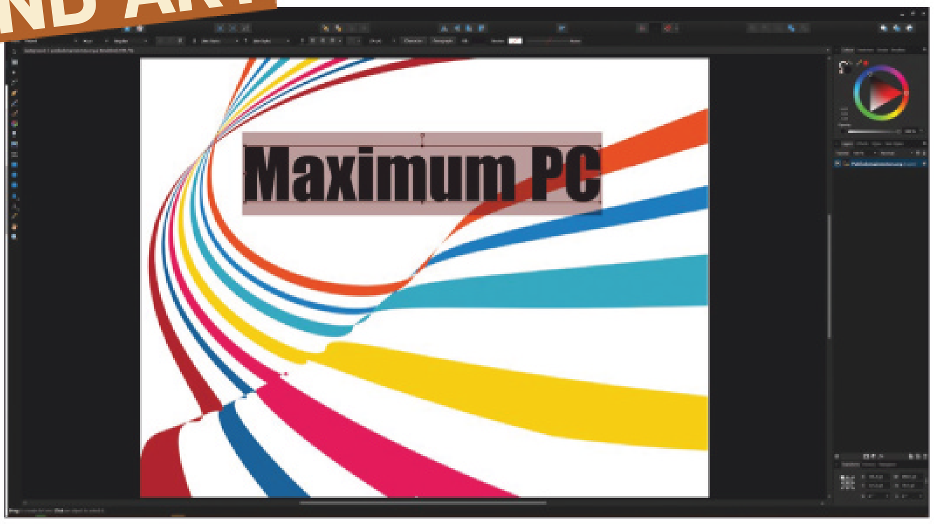
Being budget, they may not have all the bells, whistles, and advanced doodads of the big-name apps, but less expensive software has its advantages. First, you don't feel like you've lost so much if it sits there unused once the initial enthusiasm wears off. Second, it gives you the chance to experiment with something outside your comfort zone without too much of a financial risk. And thirdly, some budget software providers are branching out on their own, adding features that make them competitors to the big boys.

Take Serif. Serif Software was once the purveyor of cheap creative software that was at least functional, aimed at beginners, and sold under the Plus brand. Thus you had PagePlus for page layout and DTP, PhotoPlus for image editing, DrawPlus for illustration, WebPlus for web design, and a couple of others, too.

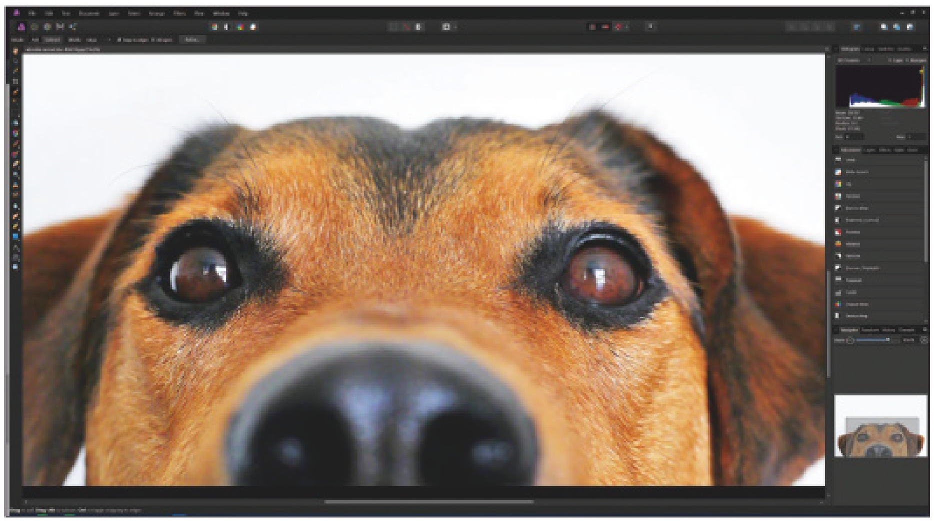
All this was swept away in 2014, when Serif released Affinity Designer, a vector drawing app that rivals Adobe's finest. It has gone on to make a name for itself in the world of pro apps, all the while keeping the price low.

Elsewhere, there are budget alternatives to big-name applications in the personal finance, music production, and system tool sectors, and loads more beside. The Windows ecosystem is so wide that, even discarding free software, you don't have to be held hostage by expensive market leaders. Unless you're working for a big publishing company that insists on using InDesign, that is....

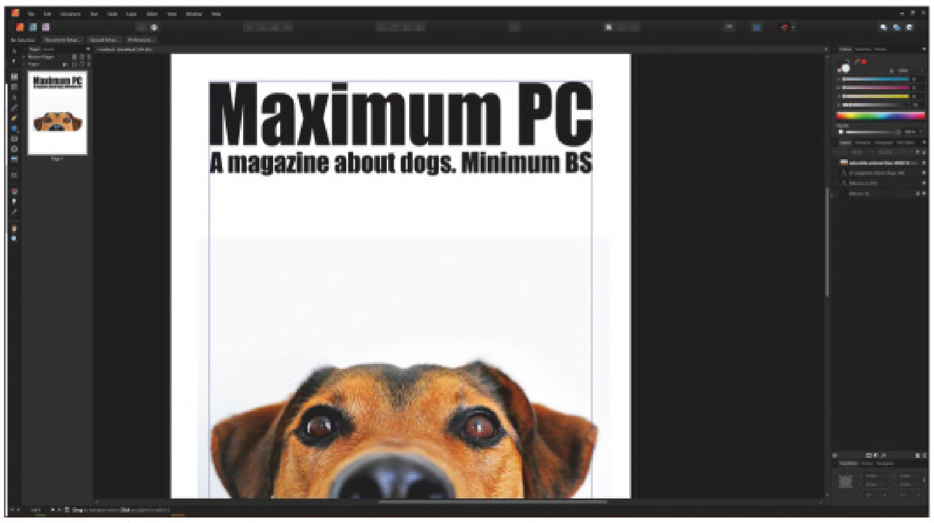
ILLUSTRATION AND ART



Affinity Designer takes on Illustrator at its own game.



Affinity Photo does what Photoshop does, for less.



Affinity Publisher, an InDesign rival, is currently in beta.

Like a lot of creative fields, vector illustration is dominated by Adobe. Its Illustrator package is available as part of the Creative Cloud subscription, which will set you back $31.49 a month if you pay monthly. It's less if you pay a year in advance, but there are cheaper alternatives.

Or at least, there are alternatives. One of the biggest competitors to Adobe has always been Corel, which maintains its own suite of creative apps, and also has a subscription model—although you can buy the software outright, too. CorelDraw trails Illustrator by two years—having been released in 1989, compared to 1987 for Adobe's app—but both programs benefited hugely from the integration of TrueType fonts in Windows 3.1. Corel was an early Windows champion, while Adobe was very Mac-focused, and nascent Windows versions of its apps lagged behind. That's all changed now, and you can circumvent the need to subscribe by purchasing CorelDraw (www.coreldraw.com) for a one-off payment of just $600 (you get the entire app suite).

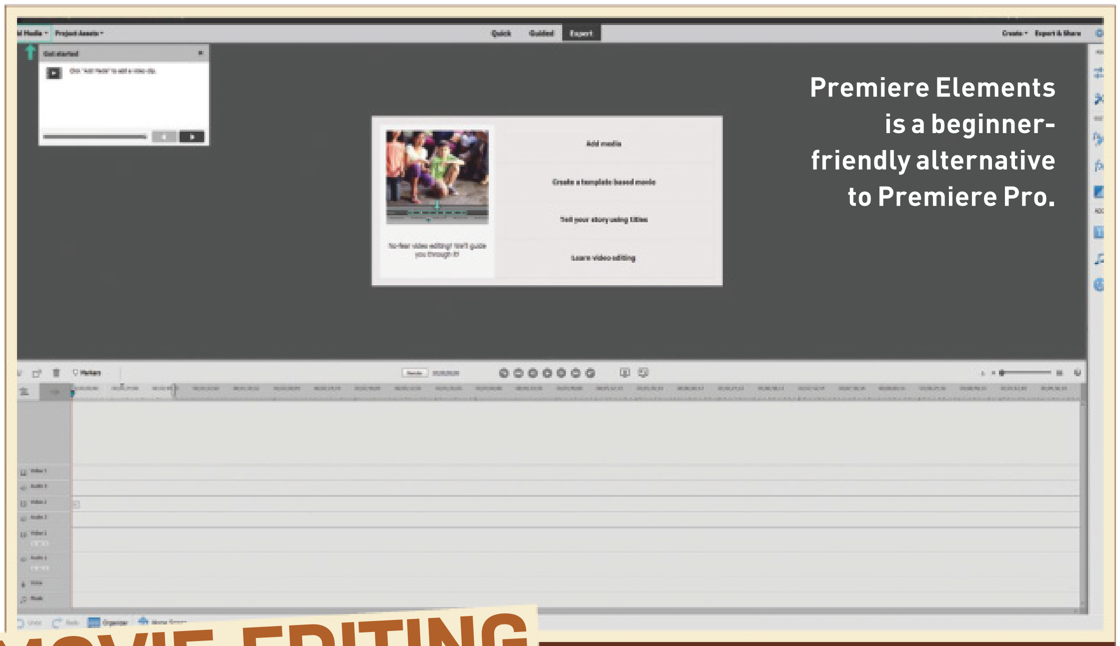
That's not very budget-friendly, so we have to look elsewhere. Xara Designer Pro (www.xara.com) is $299, so rather prices itself out, too. Serif's **Affinity Designer**, at $50, is a professional-focused app, so doesn't come with much in the way of quick fixes or Instagram-style filters, but does give you complete control over what you're doing, and comes with a set of pro-grade tools. There's a wealth of video tutorials online (www.affinity.serif.com) for those who want to master the software.

Designer offers high performance, too, as it uses hardware acceleration for 60fps panning, and a zoom that goes up to 1,000,000 percent. Most of the work is still done on the CPU, but OpenGL support means it can offload some of the workload to the GPU. For professionals, the Affinity apps support Pantone color swatches, and a full CMYK workflow, with ICC color management.

The Affinity series expanded in 2015 with the release of **Affinity Photo**, a much more wallet-friendly rival to Adobe Photoshop. **Affinity Publisher**, which takes on Adobe InDesign, is currently available as a free beta. However, betas being betas, there will be bugs right now, and Serif says up-front that it's not suitable for critical production work.

Manga or comic book creators might like to look at **Clip Studio Paint** (www.clipstudio.net), which offers tools for drawing comics and cartoons, as well as some animation features. The basic package is $50, while an enhanced EX version adds page management and pro animation for $220.

The Illustrator rivals keep on coming, too. Canvas X 2019 (www.canvasgfx.com) is a tool for detailed technical illustrations, which boasts a detail level of 0.035 microns (a human red blood cell is five microns across). It costs $300 and is somewhat niche, so why not try **Bloom**, which only costs $50? The price doesn't include updates, which are $25 a year if you want them, but the app is impressive, offering complete non-destructive editing and painting, because every filter, effect, brush stroke, or vector you create is stored as a separate object, meaning you can select it later, and tweak it. Another app called Bloom, a generative music creator by Brian Eno, tends to hog the search results, so make sure you head straight to http://thebloomapp.com.



Premiere Elements is a beginner-friendly alternative to Premiere Pro.

MOVIE EDITING

Adobe's Premiere Pro is a Creative Cloud app and therefore only available via subscription, but the movie editing scene is a really interesting one, in which pro-quality apps can be obtained for little outlay.

Premiere Elements 2019 (http://adobe.com/products/elements-family.html) is Adobe's cheaper entry into the market. It's a competent video-editing app that comes with enough tutorial support to teach you the secrets of slicing up and reassembling movie files. This beginner-friendly approach means that for anyone not already trained in the subtle art of editing, it's hard to recommend anything else, because many apps aren't intuitive for beginners. Elements 2019 is $100, or $149 if you get the bundle with Photoshop Elements. There are discounts if you upgrade from earlier versions, too.

For $100, you can also get Cyberlink's PowerDirector 17 Ultra (www.cyberlink.com), which really piles on the features. It comes with ready-made templates to appeal to beginners, but it also offers pro-level color grading, frame-by-frame object tracking, chroma-key editing for superimposing and effects, creative blending of clips, and much more. It's so overboard on the features that it can be difficult to know where to start.

Corel's VideoStudio Pro is worth a look, too, offering fast and easy movie editing. The 2018 version has a new, modern interface, along with new or updated lens correction tools, panning and zooming, 3D titles, stop motion animation, and effects. It also takes advantage of hardware acceleration to smoothly render the final result. It costs just $80. There's also an Ultimate version, with more features and add-ons, for $100.

That's not Corel's only movie app, however. It also owns Pinnacle Systems, whose Pinnacle Studio 22 (www.pinnaclesys.com) offers a more pro-oriented approach, with color grading, split-screen video with keyframes, motion tracking, 3D objects, paint effects, and more. It's available for $55, with an Ultimate version costing $110.

MUSIC PRODUCTION

Music creation apps are known as DAWs—digital audio workstations. Market leaders include Ableton Live Suite ($749), Pro Tools ($25 a month), and Logic Pro (Mac only). There are, however, some budget contenders, including **Ableton Live Intro** (www.ableton.com), which despite limiting you to 16 tracks and 8 inputs, doesn't break the bank at $99.

FL Studio—formerly Fruity Loops—(www.image-line.com) also has a basic version, **FL Studio Fruity Edition**, at $99. It's advertised as being good for creating melodies and loops (the $199 Producer Edition is for making full songs), and locks you out of things such as dragging and dropping audio clips, and using a mic, but has all the core functionality.

Reaper (www.reaper.fm) has an interesting payment model. If you use it commercially, and earn more than $20,000 from it, you pay $225. If it's for personal use, or you don't foresee making that much money, it only costs $60. You can also install it on more than one computer using the same license key, as long as you only use it on one PC at a time. Add a hardware interface and a mic, and you have a complete studio, able to import any audio or MIDI, synthesize, sample, compose, arrange, edit, mix, and master audio projects.

BenQ
A Tour of Live
Recording Audio
Creating Beats
Playing Software Instruments
Max for Live Devices
Packs
Audio I/O
MIDI Controllers

Ableton Live Intro is a fraction of the price of the entire DAW suite.

DTP

Adobe InDesign has a stranglehold on the world of publishing. Its subscription model almost puts it in the realm of home use—you only pay for it when you want to use it—but it's not for a beginner, and it's rather too much for most home uses. Adobe's great rival in the page layout space, Quark, wants $849 for a full license of QuarkXPress 2018 (there is a cheaper license, but to qualify, you have to prove you're a non-profit organization, and that doesn't mean freelancers barely making their rent). There are alternatives, however.

We were astonished to discover that Microsoft Publisher (http://products.office.com/publisher) still exists, having not used it since Office 2000, but it lives on as part of an Office 365 subscription. It's included in Home and Personal packages, but not Student, meaning the least you'll pay is $70 a year.

Serif's **Affinity Publisher** (www.affinity.serif.com), available for free while in beta, will probably be keenly priced when released, in line with the suite's other apps. Those other apps will be directly supported in Publisher, taking advantage of the suite's Persona system, which alters the look of the app and the location of tools and panels, depending on what you're doing. So, Publisher's Designer persona should integrate the vector drawing tools from the Designer app into Publisher.

Lucidpress (www.lucidpress.com) is a DTP app that runs in a browser. There's a free edition, that limits you to three pages per document, and doesn't output print-ready PDFs, and a subscription model at $6 a month, or $13 if you want to use CMYK colors.

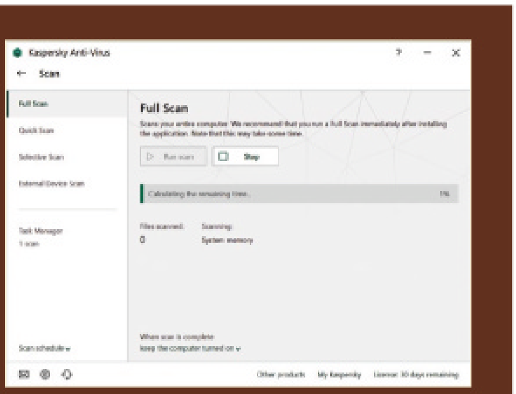
DISCOVER
NY

ANTIVIRUS

Sure, Windows Defender is pretty good, but if you're in the habit of visiting the dark corners of the Internet, opening every email attachment you're sent, and just can't resist plugging in USB sticks you find in the street and clicking on whatever EXE files you find on them, some more security might be a good idea.

McAfee Total Protection (www.mcafee.com) costs $110 a year for a version you can install across 10 PCs. You can also get AVG Ultimate (www.avg.com), which includes a PC tune-up app, too, for $100 a year. Norton Security (http://norton.com) starts to look like a budget option here, with a year's subscription for one device clocking in at $70. We can do better than that, however. Kaspersky Anti-Virus (www.kaspersky.com) will relieve you of $60 for a year's subscription, as will Bit Defender (www.bitdefender.com). At the time of writing, there are a lot of sales going on, so you may be able to secure one of these for less.

Webroot Cybersecurity (www.webroot.com) wants $30 per device per year, but true budget antivirus options are rare.



Full Scan

Scans your entire computer. We recommend that you run a Full Scan immediately after installing the application. Note that this may take some time.

Calculating the remaining time... 1%

Files scanned: 0

Scanning: System memory

When scan is complete: keep the computer turned on

License: 30 days remaining

PHOTO EDITING

Photoshop alternatives are common, some are even free, but while many apps like to style themselves as competitors to Adobe's behemoth, most fall down as they don't have the kind of tools professionals look for.

If you're not a professional, but an enthusiastic amateur, you'll have a much better time deciding what to use. Photoshop is the bargain of the Creative Cloud suite: the Photographer's Bundle offers raw processing and organization app Lightroom for $10 a month if you pay in advance, half the price of any other CC app. That may still be too much for some people, and others dislike the subscription model, so let's look at some alternatives.

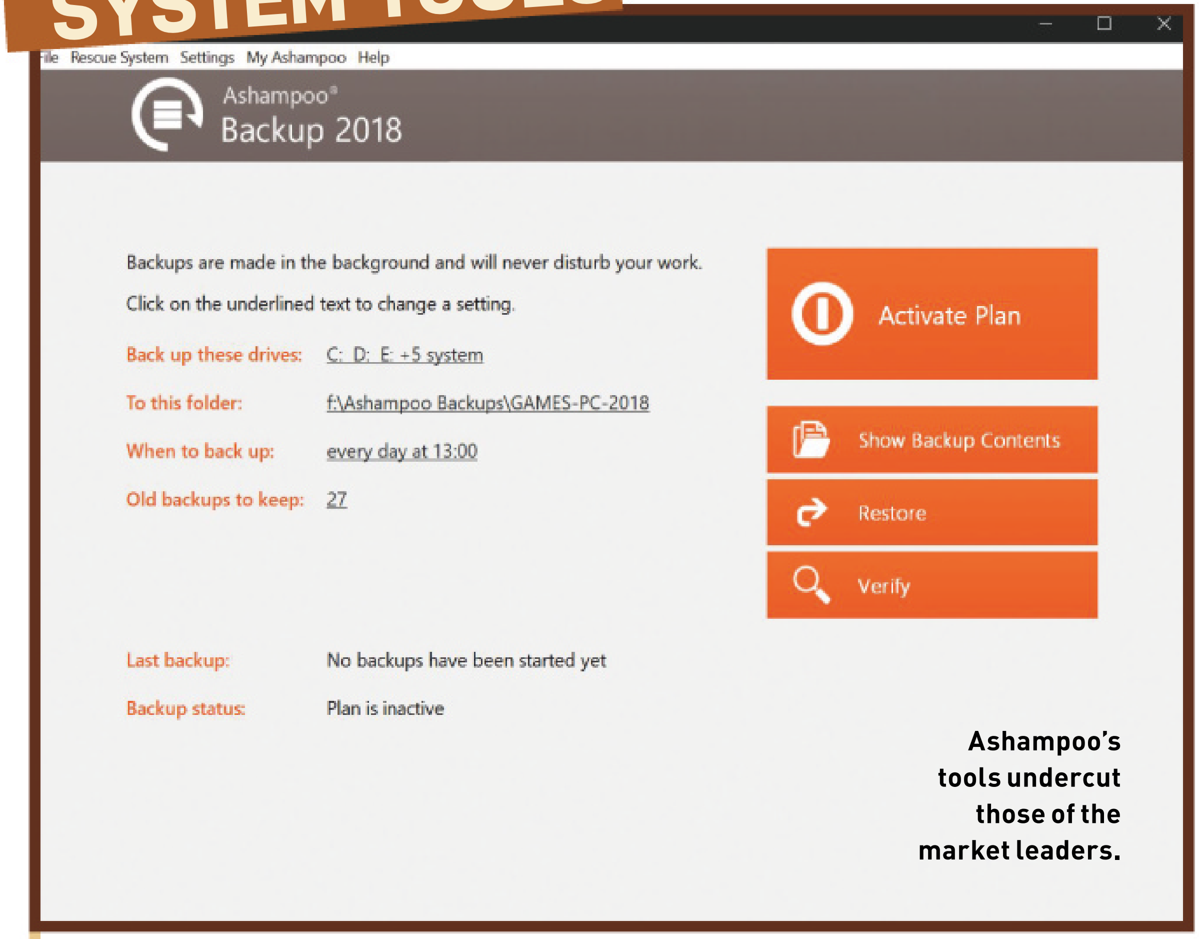
Corel's **PaintShop Pro** (www.paintshoppro.com), an old stalwart of the PC graphics scene, styles itself as the "affordable alternative" to Photoshop. You can buy it outright for $100. Its 2019 Ultimate version contains many of the same tools as Adobe's app, and adds one-click fixes and instant effects. The Ultimate bundle includes the AfterShot raw image processor, plus Perfectly Clear for one-click enhancements, and a cut-down version of the natural medium art app Painter.

Adobe's own budget app, **Photoshop Elements** (www.adobe.com/products/elements-family.html), offers all the tools most non-professionals need, and is available for $100, or $150 if you get the bundle with the Premiere Elements video-editing app.

Serif is all over this sector, and its **Affinity Photo** app (http://affinity.serif.com) is a more affordable Photoshop alternative, weighing in at $50 on the Microsoft Store. There's also an iPad version that's a pretty good port of the desktop app, along with a similar port of the Designer vector graphics app. They retail for $20 each, but you'll need a recent iPad to be able to run them.

Special mention has to go to **Photopea** (www.photopea.com), a student project that's become a full-fledged image editor that runs in your browser. It's nominally free, but a subscription model removes ads for $20 every three months.

SYSTEM TOOLS



Backups are made in the background and will never disturb your work.

Click on the underlined text to change a setting.

Back up these drives: C: D: E: +5 system

To this folder: f:\Ashampoo Backups\GAMES-PC-2018

When to back up: every day at 13:00

Old backups to keep: 27

Last backup: No backups have been started yet

Backup status: Plan is inactive

Ashampoo's tools undercut those of the market leaders.

Create
Share
Quick
Guided
Expert

Photoshop Elements is full of guided tutorials.

There are a lot of tools that come with Windows, but sometimes you need something more powerful, or a feature Microsoft hasn't supplied.

The venerable **Norton Utilities** (http://norton.com) has moved to a subscription model, wanting $40 a year. That allows you to use it across 10 PCs, so it may make sense if you've got a lot of computers and it's critical they're all working at their best. In the world of backups, **Acronis True Image 2019** can be bought for $50, but also has a subscription model for its Advanced and Premium tiers that will set you back $50 and $100 a year respectively.

There are other choices, including **AVG TuneUp**, a performance optimizer that needs to be subscribed to for $50 a year, but can be installed on unlimited systems. It removes unwanted programs and temporary Internet files, and will even attempt to clean up your registry, if you dare.

CCleaner (www.ccleaner.com) speeds up your PC by cleaning away all the unused files and settings that accumulate after you've been using a PC for more than a few minutes. It also optimizes your PC for faster startups and, in its paid-for version, offers real-time protection and online privacy enhancement, too. It's a subscription, but only $35 a year. The same company also offers **Recuva**, a $20 file recovery app that can copy files from damaged disks, music players, and memory cards, plus create disk images for archiving.

You can't talk about budget apps without mentioning Ashampoo (www.ashampoo.com). This German company offers backup software (called **Backup**), for when OneDrive and File History aren't enough, at $30. There's more: Ashampoo's **WinOptimizer** does a similar job to CCleaner for $40, and there's a file compression suite, **Zip Pro 2**, for $30.

Elsewhere, EaseUS (www.easeus.com) offers partition management software for $40, with the ability to migrate an OS to a new drive, manage dynamic volumes, and create boot disks for the Windows Preinstallation Environment, for when you need to troubleshoot an OS while it's offline. EaseUS also offers backup software for $30, supporting system cloning, the transfer of a system to a new PC, and offsite copying.

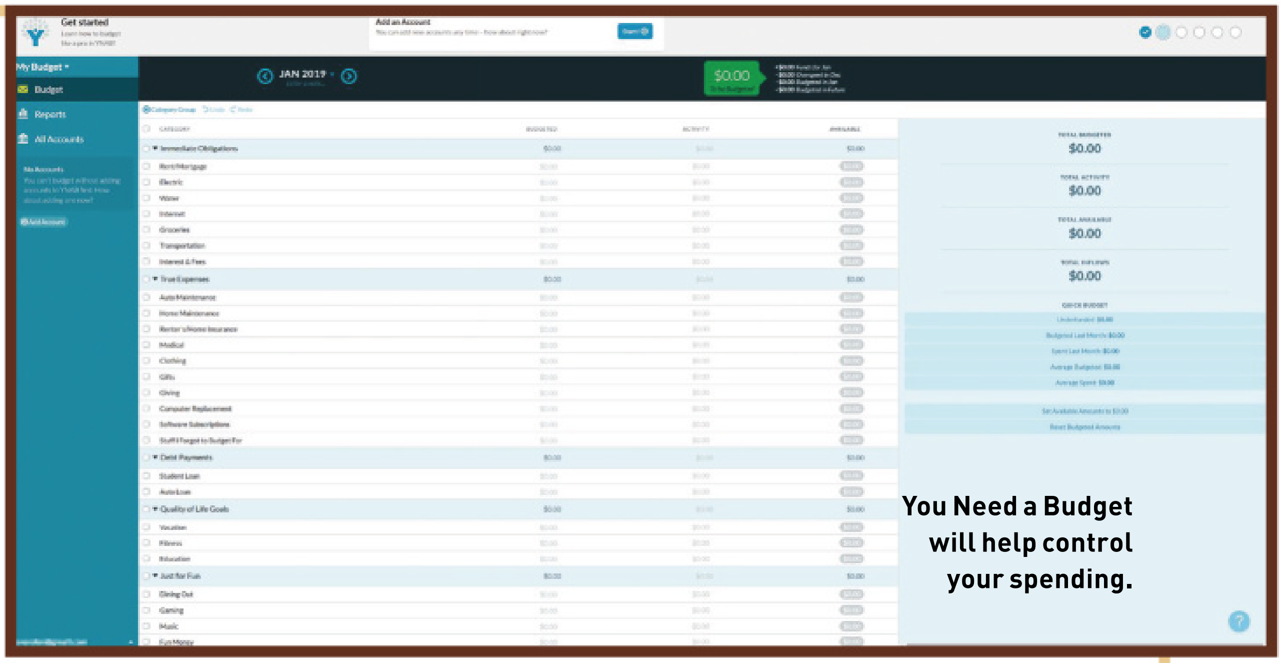
FINANCE

It seems appropriate in a feature aimed at helping you save money that we include apps designed to help you save money. Some would say that Microsoft Excel is the best budgeting app, enabling you to set up a spreadsheet to track income and expenditure. Free office apps are, of course, available as an alternative, but for those not steeped in the lore of office management, they can be a bit austere and unfriendly. Enter the personal finance app, designed to streamline the process of paying your bills, doing your taxes, and maybe managing some savings, too. They're also useful for small business administration, and some are tailored to precisely this.

Microsoft used to have more skin in this game in the form of Microsoft Money, which no longer exists… except it does, as Money Plus Sunset Deluxe, a free download. That's free, not budget, however, and with small-business market leader QuickBooks Pro coming in at $300 or a subscription, the same company's personal app **Quicken** (www.quicken.com) looks more reasonable at $35 a year. The Deluxe package, at $50 a year, adds features such as savings goals and customized budgets.

Elsewhere, **You Need a Budget** (www.youneedabudget.com) sets you back $7 a month, and maps out how much money you have to spend each month. You assign each dollar a job by separating your checking account into categories, so you can see exactly how much you have to spend on everything you need, and how much is left over.

AceMoney (www.mechcad.net) costs $40, and while a lot less flashy than other apps (it only needs 8MB of RAM), it comes with over 100 categories to split your income into, and handles exchange rates if you're paid from abroad.



You Need a Budget will help control your spending.

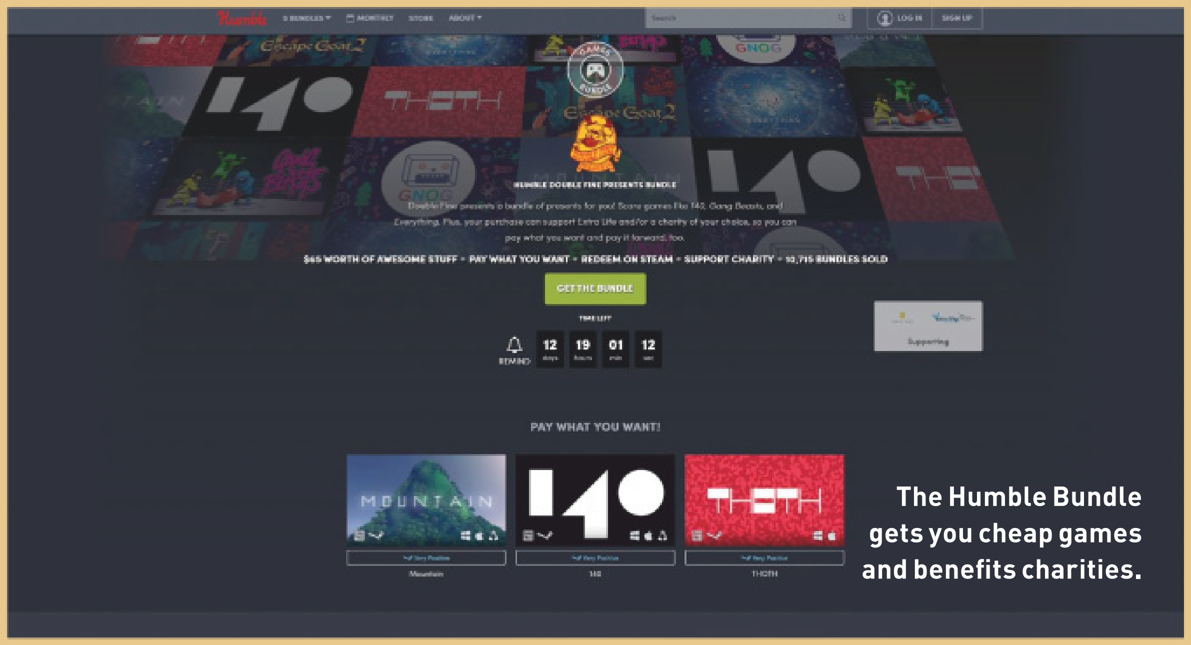
techradar

BUDGET GAMES

Playing the latest games requires a powerful computer, so it's not really what you'd call a budget-friendly hobby. If you're just curious, or not bothered about 4K and 60fps, however, you can get a surprising amount of performance out of a modest PC. Games charging $60 on launch, however, can put some people off. But there are ways to get amazing gaming experiences for a lot less cash.

The **Humble Bundle** (www.humblebundle.com) offers a regular bundle of games at a discount, with some of your money also going to a good cause. It's a pay-what-you-want arrangement, with a minimum amount. Paying more often unlocks more games, and it's a good way of building up a library of titles without spending a fortune. There's a subscription that gets you every bundle as it's released, or you can pick and choose. Also worth checking out is **Good Old Games** (www.gog.com)—a site that began as a repository of older games, but has caught up with sales of new titles, too. If there's a PC game you remember from your misspent youth, and you feel like playing it again, there's a good chance GOG has it in a format that will work on a modern machine.

The digital distribution marketplace is really heating up following the launch of stores by Bethesda and Epic. Once, Steam completely ruled this realm, with only Ubisoft's Uplay to challenge it. That's all changed, however, as even streaming platform Twitch is now selling games, so discounts are coming in harder and faster in an attempt to win your dollar away from competitors. With frequent sales and special offers, it has never been easier to pick up a recent game at a bargain price. ⏻


Humble
LOG IN
SIGN UP
HUMBLE DOUBLE FINE PRESENTS BUNDLE
$65 WORTH OF AWESOME STUFF • PAY WHAT YOU WANT • REDEEM ON STEAM • SUPPORT CHARITY • 10,715 BUNDLES SOLD
GET THE BUNDLE
12
19
01
12
PAY WHAT YOU WANT!
MOUNTAIN

The Humble Bundle gets you cheap games and benefits charities.

The home of technology

techradar.com

EXPLORE THE HEAVENS

It's time to discover and explore the night sky with a little open-source software, your own two eyes, and the help of ***Mike Bedford***

"SPACE IS BIG. Really big. You just won't believe how vastly hugely mindbogglingly big it is. I mean, you may think it's a long way down the road to the chemist, but that's just peanuts to space." OK, so these words from Douglas Adams's spoof sci-fi novel *The Hitchhikers' Guide to the Galaxy* might have been intended as a bit of silliness, but the sentiment is true.

Based on the latest data from the Hubble Space Telescope, astronomers estimate there are 700 sextillion (that's 700 thousand billion billion) stars in the visible universe. Trying to get your head around such a vast number of objects—or even just those that can be seen from Earth with the naked eye—is, well, mindboggling. But we're here to help.

Our aim is to aid those who are fascinated by the sky at night, but know little about those countless pin pricks of light on display, to take their first steps in practical astronomy. First, we'll see how open-source software can help you plan your star-gazing by showing you what will be visible at any time, and where to look. Then, armed with this information, we'll provide you with some practical guidance on how to observe some of these astronomical objects with nothing more than a pair of binoculars.

Some objects will never look like more than tiny points of light, so next we'll use software to shed more light on these alien worlds, even showing you how they'd look if you were to go there.

The software we've chosen to help you plan a night of practical astronomy is the highly regarded open-source Stellarium. It generates an image of the sky as it would appear from any point on the Earth's surface, at any time—past, present, or future. Usually, you'd use it to show the night sky as it will appear at your planned observation location at the current time. However, there will be times when you'll want to see the sky as it will look a short time into the future, as an aid to planning your observations.

GET THE MOST FROM STELLARIUM

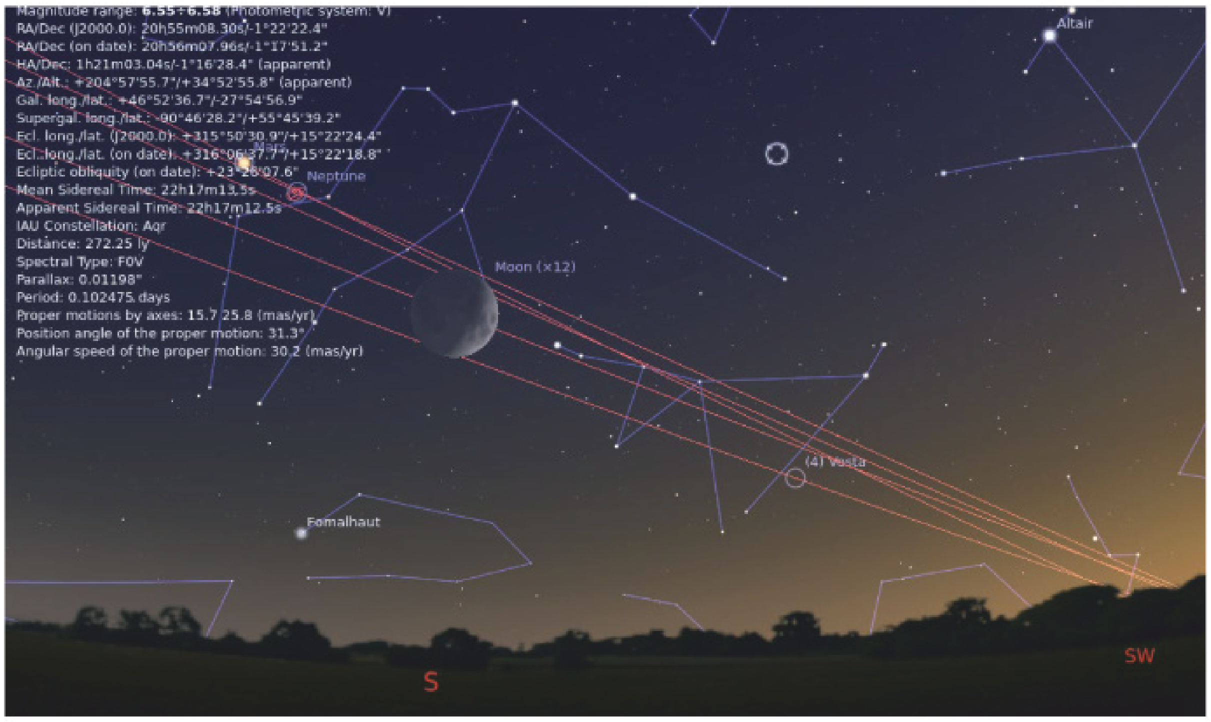
Stellarium is unusual in not having a conventional menu bar. Instead, it's driven mainly via two toolbars, which are normally hidden. They are displayed by moving the pointer to the bottom or left of the screen, near the bottom-left corner. Select a town or city close to your location, and the time you're interested in, using options in the left-hand toolbar.

You can also select which types of objects to display (stars, planets, moons, or asteroids), and filter the display labels according to the brightness of the objects. With this option, you can find a compromise between not being able to identify objects you're interested in, and seeing so many labels that the screen is utterly confusing. Another option is to display the lines that define constellations, to show their names, and even add an image. So, for example, having displayed the lines and the name of the constellation Orion, you can superimpose the artwork of the hunter. Of course, constellations have no astronomical reality. So, for example, the seven stars that constitute the Big Dipper, which form part of the constellation Ursa Major, appear to be close together, but this is an illusion, as they vary from 58 to 124 light years away (300–750 trillion miles). Often, stars in a constellation appear to be of similar brightness because the more distant stars are larger than the closer ones.

As a final comment on Stellarium, it often displays stars that you can't see in the sky with the naked eye. This might seem pointless, but more objects are visible if you use binoculars, and more still appear if you use a telescope. In addition, Stellarium can also display objects that you can't always on screen because they're so faint. For this reason, the authors suggest using Stellarium in a darkened room.

PRACTICAL OBSERVATION

The easiest way to start your voyage of discovery is to observe the night sky outside your home. However, unless you live away from centers of population, the sky will suffer from



```
Magnitude range: 6.55÷6.58 (Photometric system: V)
RA/Dec (J2000.0): 20h55m08.30s/-1°22'22.4"
RA/Dec (on date): 20h56m07.96s/-1°17'51.2"
HA/Dec: 1h21m03.04s/-1°16'28.4" (apparent)
Az./Alt.: +204°57'55.7"/+34°52'55.8" (apparent)
Gal. long./lat.: +46°52'36.7"/-27°54'56.9"
Supergal. long./lat.: -90°46'28.2"/+55°45'39.2"
Ecl. long./lat. (J2000.0): +315°50'30.9"/+15°22'24.4"
Ecl. long./lat. (on date): +316°06'37.7"/+15°22'18.8"
Ecliptic obliquity (on date): +23°26'07.6"
Mean Sidereal Time: 22h17m13.5s
Apparent Sidereal Time: 22h17m12.5s
IAU Constellation: Aqr
Distance: 272.25 ly
Spectral Type: F0V
Parallax: 0.01198"
Period: 0.102475 days
Proper motions by axes: 15.7 25.8 (mas/yr)
Position angle of the proper motion: 31.3°
Angular speed of the proper motion: 30.2 (mas/yr)
```

Stellarium helps you plan a night's stargazing by showing what will be visible at your location.

light pollution, so you'll struggle to see some objects that would be clearly visible in more remote areas. The upshot of this is that you might need to put your laptop in the car, and go in search of darker skies.

It's not just the sky that can hinder your observations; your own eyes can work against you. When you first go out into the dark, your eyes won't be sensitive to dim objects. For this reason, unless you're looking for something bright, such as the moon, Mars, Saturn, or Jupiter, you'll need to wait a few minutes for your eyes to adjust. Remember that this adaptation is reversed if you look at anything bright, and that includes your laptop screen. So, if you want to refer to Stellarium during your observations, select its night vision display mode, which renders the sky in dark red on black.

Stellarium shows compass bearings, so you know which direction to look to see a given object. Unless you know where each of the compass points lies, you'll need to use a compass or a compass app on your smartphone, to figure out where to look. Alternatively, there are Android apps that provide similar functionality to Stellarium, but which use your phone's sensors, so the display reflects the actual direction the phone is pointing. We used SkEye, but there are loads of others, many of them free, so you can try them out to see which you like best.

Now you know what you ought to be able to see, and where to look, we need to cover the practicalities of observing astronomical objects. To start, we suggest you use nothing more than your own eyes. You won't need any instructions, or the help of Stellarium, to see the moon, but do spend a few minutes to identify those bright planets that might be visible, and here we include Venus, Mars, Jupiter, and Saturn. Next, try looking for some of the constellations that Stellarium shows you.

The next step is to use binoculars. These will help you to see lots of objects that Stellarium identifies, but are invisible to the naked eye. However, some of the most interesting objects to observe when you're starting out are ones you've already identified with the naked eye, because you can often see so much more.

We recommend starting with the moon, where binoculars can help you to differentiate the dark-colored plains from the light-colored highlands, and reveal some of its many craters. You could also turn your attention to the red planet, Mars, but although your binoculars will show it as a larger and redder dot, you won't see any additional detail.

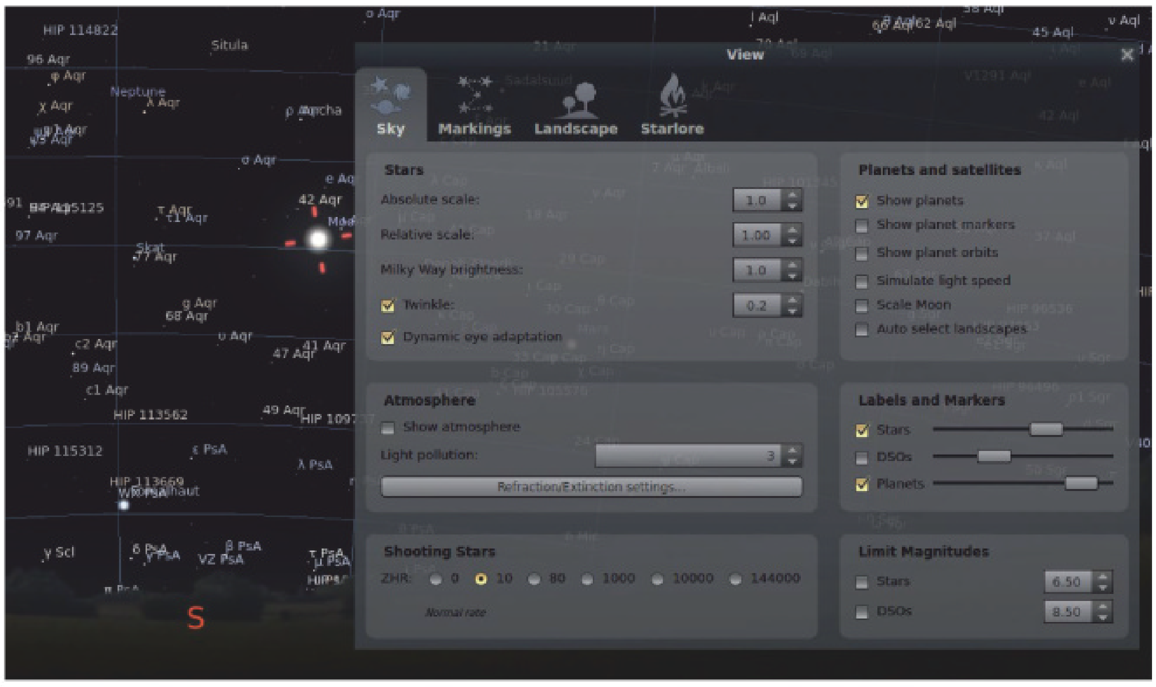
However, for something that's almost guaranteed to amaze you, if you've not seen it before, train your binoculars on Jupiter. With the naked eye, it's just a dot, but through binoculars, that dot has up to four smaller dots close by. These dots, which shift in position with respect to Jupiter over time, and are sometimes behind the planet and hence invisible, are called Callisto, Europa, Ganymede, and Io. These are the four largest of Jupiter's many moons, and are known as the Galilean moons, after their discoverer.

ONWARD TO VENUS!

Now on to a couple of more challenging observations, and here, if your binoculars have a suitable mount, it would help to attach them to a tripod to help keep the image steady. First, take a look at Venus. If your binoculars are good enough, and depending on the date, instead of the dot you saw with your naked eyes, it might appear as a crescent or a half circle. This is because, just like the moon, the planet Venus displays phases. And second, turn your attention to Saturn. If you notice that it isn't perfectly circular, or if it appears to have ears, you're actually seeing its rings, even though you'd need a telescope to see them more clearly. You might also be able to see Saturn's brightest moon, Titan.

As we turn our attention beyond the solar system, binoculars are again able to reveal detail that is otherwise invisible. For example, not all objects that appear to the naked eye as a single dot of light are what they seem. Some objects that look like stars are actually double stars, and appear as such through binoculars. In some cases, the two stars only appear to be close together from our viewpoint on Earth, while others are actually a pair of stars orbiting around each other.

A good one to spot is Mizar in the handle of the Big Dipper, although some people



Stars

Absolute scale: 1.0

Relative scale: 1.00

Milky Way brightness: 1.0

☑ Twinkle: 0.2

☑ Dynamic eye adaptation

Atmosphere

☐ Show atmosphere

Light pollution: 3

Refraction/Extinction settings...

Shooting Stars

ZHR: ○ 0 ● 10 ○ 80 ○ 1000 ○ 10000 ○ 144000

Normal rate

Planets and satellites

☑ Show planets

☐ Show planet markers

☐ Show planet orbits

☐ Simulate light speed

☐ Scale Moon

☐ Auto select landscapes

Labels and Markers

☑ Stars

☐ DSOs

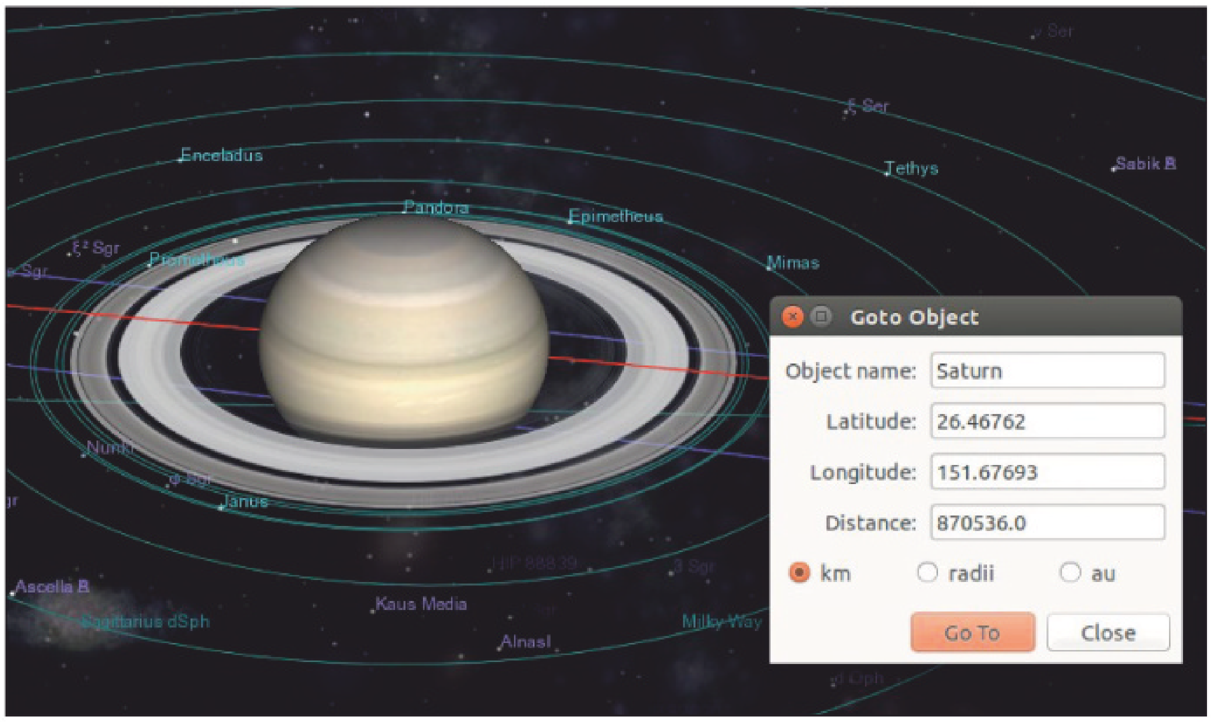
☑ Planets

Limit Magnitudes

☐ Stars 6.50

☐ DSOs 8.50

Display as much information as you want, thanks to Stellarium's myriad options.



Object name: Saturn
Latitude: 26.46762
Longitude: 151.67693
Distance: 870536.0
● km ○ radii ○ au

Like Stellarium, Celestia provides plentiful options, so you can decide exactly what to display.

can see two stars unaided. However, one of the most spectacular double stars is Albireo in the constellation of Cygnus. You'll have to wait until summer, and you need a good pair of binoculars to see it, but it's particularly spectacular because the two stars are different colors—blue and amber.

ZOOMING IN WITH CELESTIA

Having seen some of the remarkable objects in our solar system and beyond with your own eyes, perhaps aided and abetted by a pair of binoculars, you'll surely be interested to learn more about some of these planets, moons, and stars. After all, even with good binoculars, many of them still only appear as specks of light, and that begs the question of what they would really look like if you were able to visit them.

To help answer that question, we're turning our attention to another open-source package, called Celestia. Before we get started, though, we should point out that, despite it having an enthusiastic following, it's not updated as frequently as we might hope, with the result that it doesn't appear in some of the more recent Linux repositories (if you're exploring the heavens with an open-source bent). You can grab the latest version of Celestia for Windows by pointing your browser of choice at www.celestia.space, clicking the download tab at the top of the page, and then electing to download the newest (or if you'd prefer, the previous) build.

When you first start Celestia, you see an image of the Earth as it would appear from orbit and, already, you're seeing something markedly different from the view provided by Stellarium, which shows you how the sky looks from the Earth's surface. Indeed, Celestia enables you to define a viewpoint anywhere in the solar system or, for that matter, far beyond. For views of the planets in our solar system and their moons, the view that you see uses actual photography of those bodies, as captured by NASA's various planetary probes. And for more distant objects that spacecraft have never visited, the image you see is based on the scientific view of what they probably look like.

Let's imagine that you observed the planet Jupiter with your naked eyes, and then discovered its four Galilean moons using binoculars. In that case, you could well be interested in seeing what those white dots would really look like from a spacecraft in close proximity.

Let's start with Io. Search for it in the "Navigation" menu, then select "Goto Object." Io is displayed from some arbitrary distance, but if it's too small, you can select a smaller distance in the "Goto Object" window. When you start to see the detail on the surface of Io, you'll notice several small dark circles, which are volcanoes. It transpires that Io is the only known object in the solar system, other than the Earth, to have active volcanoes.

So far, you've seen Io, but depending on when you view it, it might not be obvious that it's orbiting Jupiter. Probably the best way to address this is to fast-forward, by repeatedly using the "10x Faster" option in the "Time" menu—eventually, you'll see Io in relation to Jupiter.

Going beyond Io, you really ought to take a look at Jupiter's other large moons. If you expected that every Jovian moon would look similar, you'll be in for a surprise. Also, as with Stellarium, you have total control over what's displayed on screen. You can turn the outlines of constellations on and off, choose what, if any, types of objects to label, and display orbits, information on the selected object, and so much more.

In our use of Celestia so far, we've positioned ourselves at fixed points in space to get a good view of the objects we're interested in. This is just a start, though, and if you want something a little more interactive, you can even view the heavens while taking the controls of a simulated spacecraft. In addition to flying between planets and stars, you can go into orbit around them, and you can even land on the surface of planets and moons. We'll leave you to figure all this out yourself, for which you'll probably need to consult the comprehensive user guide at www.celestiamotherlode.net/catalog/documentation.html.

Celestia will keep you entertained for countless hours, just by trying things out yourself. However, your enjoyment of Celestia, and the whole universe for that matter, can be enhanced by taking advantage of the contributions of others. A useful feature of Celestia is the ability to create and play back scripts, something that lots of users have employed to produce animated tours of parts of the solar system and beyond. The best place to find add-ons for Celestia is www.celestiamotherlode.net. We're confident that you'll find plenty here to enhance your appreciation of the sky at night, and help you to better understand the remarkable worlds that are just waiting to be discovered. ⏻

SHOOTING STARS

If you want to be inspired by the variety and beauty of distant words, visiting the NASA Image Galleries at www.nasa.gov/multimedia/imagegallery is a must.

Although NASA's images are static, the amount of detail you can see is staggering. For example, returning our attention to Jupiter's moon Io, you can even see the plume of one of its volcanoes firing sulphur 200 miles into space. And in addition to seeing how planets and moons looked from fly-bys or from orbit, in the case of Mars, you can look at images from the planet's surface, as captured by the various Martian rovers. You can even view images of the moon's surface captured by astronauts in the Apollo missions that took man to the moon from 1969 to 1972.

It's not just the solar system you can see in minute detail—thanks to the Hubble Space Telescope, you can start to appreciate the wonders of the stars beyond our immediate neighborhood.

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MAXIMUM PC'S 15TH IRREGULAR GEEK QUIZ

MAXIM
UNIVE

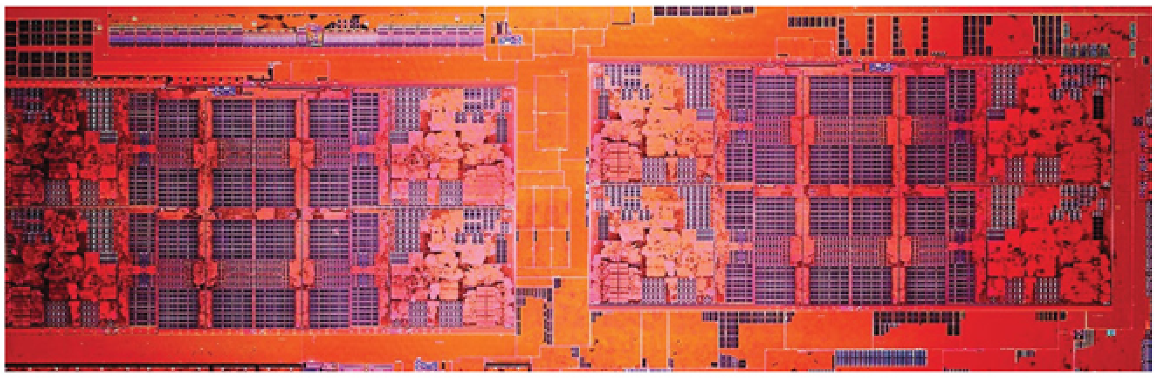
SO, YOU THINK YOU KNOW YOUR STUFF? WE'LL BE THE JUDGE OF THAT

BY CHRIS LLOYD

WE'VE BEEN BRINGING YOU the skinny on all things PC, and now we want to see if you've been paying attention. What better way than some friendly questioning to see what stuck inside that noodle. And so we present another in our irregular series of Geek Quizzes, formulated to stretch your head with all things tech-related. We've seven magical sections of seven questions, covering all things PC, some more general tech, and Internet stuff. It's the kind of thing you should know if you've been following *Maximum PC* and have any aspirations of geekdom. There are questions your pet can probably answer, some that are much more fiendish, plus the odd trick one.

We recommend you try this well away from the temptation of the Internet. Yes, you can sit and Google your way through this (other search engines are available), but where is the challenge in that? Why not see how you really score at the *Maximum PC* University, and go old school? We dare you. There's no prize, apart from that warm glow if you do well. Statistically, you will score 14 by random guessing, so let's see how much better you can do than that. Ready?

Silicon City



1 We know that Threadripper 2 is a big chip—how big exactly?

A) ☐ 213mm^2
B) ☐ 231mm^2
C) ☐ 312mm^2
D) ☐ 321mm^2

2 How many High-Speed I/O lanes are there on Intel's Z390 chipset?

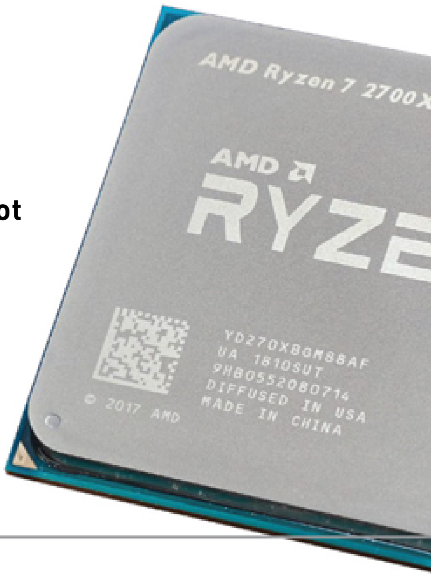
A) ☐ 24
B) ☐ 30
C) ☐ 32
D) ☐ 36

3 How many usable PCIe lanes are there on a Ryzen 2700X?

A) ☐ 20
B) ☐ 24
C) ☐ 36
D) ☐ 44

4 Which of these is not an Intel code name?

A) ☐ Tiger Lake
B) ☐ Lizard Head Pass
C) ☐ Sunny Lake
D) ☐ Willow Cove



UMPC
ERSITY

5 **Who manufactured the first 7nm chips to reach the market?**

A) ☐ Apple
B) ☐ Huawei
C) ☐ Intel
D) ☐ TSMC

6 **What is the maximum clock speed on an Intel HD 630?**

A) ☐ Half of the CPU base clock
B) ☐ One quarter of the CPU base clock
C) ☐ 950MHz
D) ☐ 1,150MHz

7 **What kind of chip is Dhyana?**

A) ☐ A reverse-engineered AMD EPYC
B) ☐ An unlicensed clone of AMD's EPYC
C) ☐ A licensed version of AMD's EPYC
D) ☐ A new design of x86 processor

Graphics Gear

8 **How wide is the Turing TU102's memory bus?**

A) ☐ 256-bit
B) ☐ 384-bit
C) ☐ 352-bit
D) ☐ 320-bit

9 **Which isn't part of the Turing architecture?**

A) ☐ Mesh Shading
B) ☐ Bidirectional Shadow Paths
C) ☐ Variable Rate Shading
D) ☐ Voxel Ambient Occlusion

10 **How fast can a GDDR6 memory chip run?**

A) ☐ 14Gb/s
B) ☐ 16GB/s
C) ☐ 16Gb/s
D) ☐ 672GB/s

RTX 2080Ti
NVIDIA

11 **What is the most commonly used ray-tracing acceleration algorithm?**

A) ☐ Volume Intersection Predictions
B) ☐ Path Intersection Hierarchy
C) ☐ Ray Casting Intersections
D) ☐ Bounding Volume Hierarchy

12 **The Radeon VII card features which GPU?**

A) ☐ 7nm Vega 20
B) ☐ 7nm Vega 2
C) ☐ 7nm Vega
D) ☐ 7nm Navi

13 **How many games supported RTX's ray-tracing features at the card's launch?**

A) ☐ None
B) ☐ 7
C) ☐ 11
D) ☐ 27

14 **HDMI 2.1 introduces new cables, what are they called?**

A) ☐ Ultra High Speed HDMI
B) ☐ 10K HDMI
C) ☐ Ultra Resolution HDMI
D) ☐ Super Speed HDMI

Storage Stuff

Western Digital
Ultrastar
DC HC620
DATA CENTER SMR DRIVE
HelioSeal
HELIUM TECHNOLOGY
15TB

15 How many HDD manufacturers are left?

A) ☐ Two
B) ☐ Three
C) ☐ Four
D) ☐ Five

16 What is the minimum number of drives in a RAID Level 10 system?

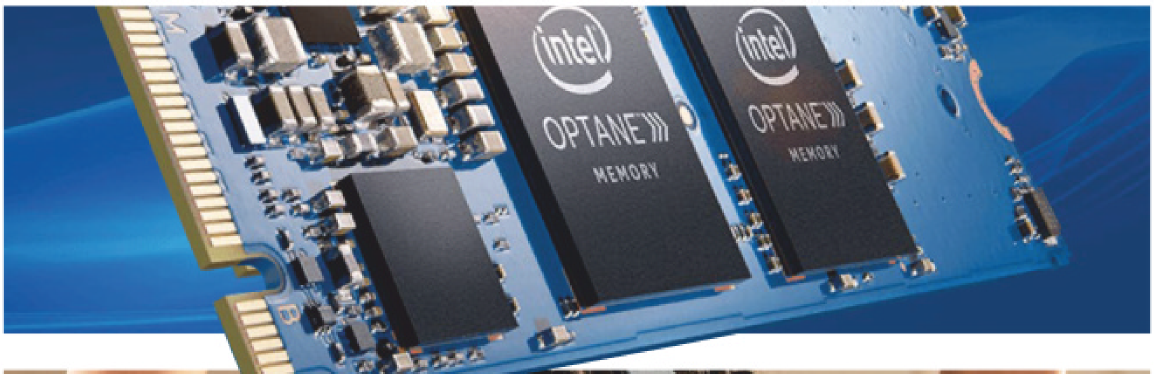
A) ☐ Two
B) ☐ Four
C) ☐ Six
D) ☐ Eight

17 QuantX is a version of which technology?

A) ☐ 3D XPoint
B) ☐ DTS:X
C) ☐ X-IO
D) ☐ X-Mine

18 Nimbus Data has built the largest SSD drive ever made. How big is it?

A) ☐ 16TB
B) ☐ 48TB
C) ☐ 64TB
D) ☐ 100TB



19 Western Digital's 15TB Ultrastar drive uses what form of recording technology?

A) ☐ Heat-assisted magnetic recording
B) ☐ Perpendicular recording
C) ☐ Shingled magnetic recording
D) ☐ Triple density longitudinal recording

20 What is M.2, basically?

A) ☐ A device interface to connect SSDs to the PCIe bus
B) ☐ A set of physical specifications for an expansion card
C) ☐ A specification for an expansion card that carries NVMe
D) ☐ A multi-purpose interface protocol

21 AHCI has one command queue with 32 commands; what does NVMe feature?

A) ☐ 64K command queue with 64K commands per queue
B) ☐ 64K command queue with 32K commands per queue
C) ☐ 32K command queue with 64K commands per queue
D) ☐ 32K command queue with 32K commands per queue

Other Hardware

22 An acid green USB port means what?

A) ☐ A style choice
B) ☐ Charging only
C) ☐ Unofficial protocol
D) ☐ Always on

23 Why will Wi-Fi 6 be faster?

A) ☐ Smaller FFT sizes
B) ☐ Higher wattage transmitters
C) ☐ Increased spectrum efficiency
D) ☐ Lower spectrum bands

24 Where would you want good ripple suppression?

A) ☐ Ethernet cables
B) ☐ Main memory bus
C) ☐ Motherboard VRMs
D) ☐ PSU

Other Hardware *(cont.)*

25 **The PCIe 3.1 specification defines how many lanes a device can be assigned—which of these are within specifications?**

A) ☐ x12 and x24
B) ☐ x24 and x32
C) ☐ x12 and x32
D) ☐ x12, x24, and x32

26 **What is the resolution of the Oculus Go, per eye?**

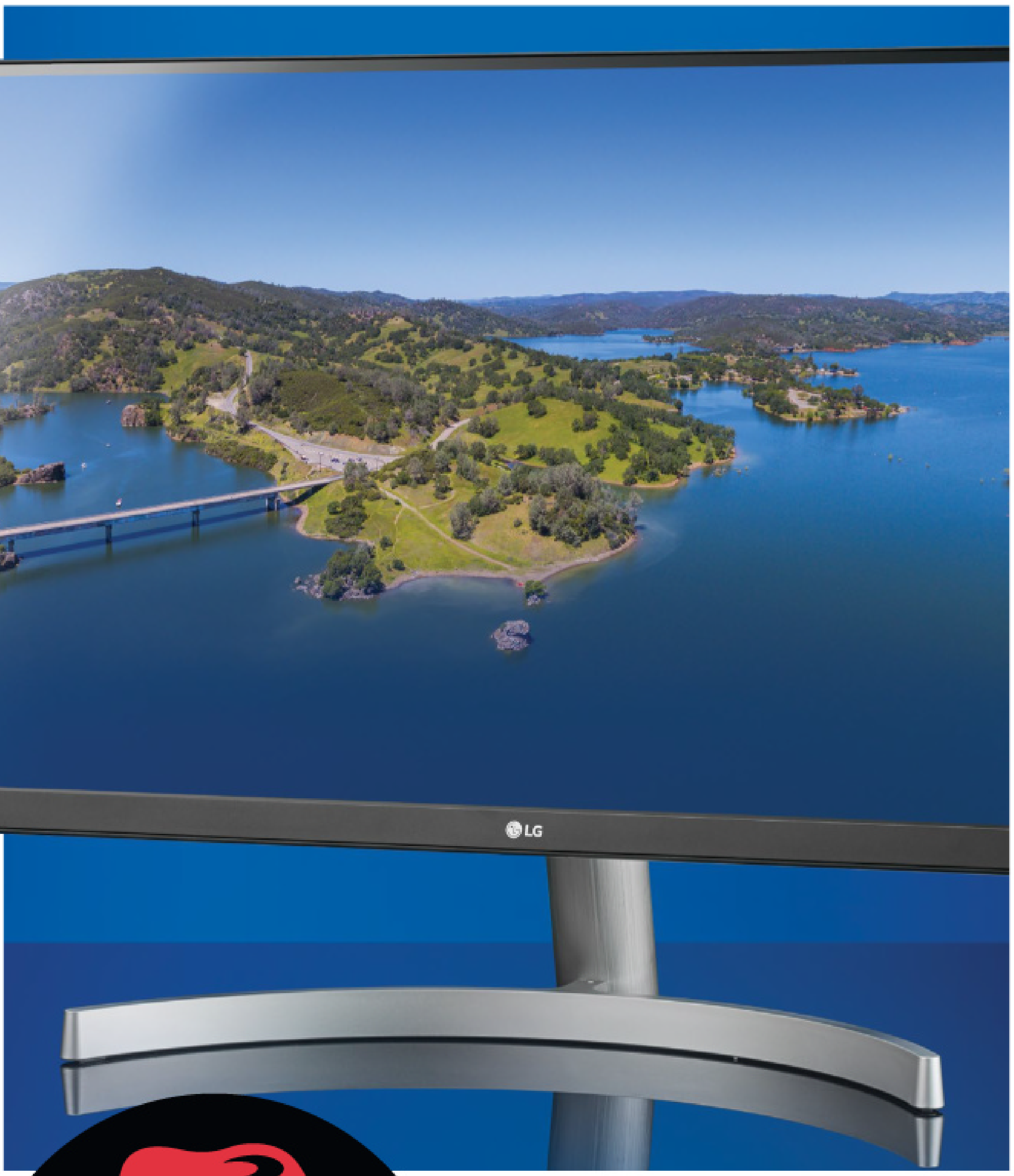
A) ☐ 960x1,080
B) ☐ 1,440x1,600
C) ☐ 2,560x1,440
D) ☐ 1,280x1,440

27 **The Digital Cinema Initiative would like your monitor to be what aspect ratio for 4K digital films?**

A) ☐ 21:9
B) ☐ 256:135
C) ☐ 64:27
D) ☐ 1,024:429

28 **PCIe 4.0 is due soon; how much power will we get from a x16 slot?**

A) ☐ Doubled to 150W
B) ☐ Tripled to 225W
C) ☐ More than 300W
D) ☐ The same as PCIe 3.0: 75W



Operating Systems

29 **How much did IBM spend buying Red Hat Linux last year?**

A) ☐ $34 million
B) ☐ $340 million
C) ☐ $3.4 billion
D) ☐ $34 billion

30 **How many Windows PCs still run Windows 7 worldwide, roughly?**

A) ☐ 24%
B) ☐ 33%
C) ☐ 42%
D) ☐ 49%

31 **What is Windows 10's theoretical maximum resolution?**

A) ☐ 4K x 4K
B) ☐ 4K x 8K
C) ☐ 8K x 8K
D) ☐ 16K x 16K

32 **Which of these names isn't connected to a version of Windows 10?**

A) ☐ Threshold 3
B) ☐ Redstone 5
C) ☐ 19H1
D) ☐ November Update

33 **One of these isn't a Windows acronym, which is it?**

A) ☐ WSH
B) ☐ WPT
C) ☐ WSB
D) ☐ WUA

34 **If you grab a window by the top bar and shake it vigorously, what happens?**

A) ☐ It switches to full screen
B) ☐ All your other applications attempt to close down
C) ☐ All the other open windows minimize
D) ☐ All your applications switch to full screen

35 **When will support for Windows 10 Mobile end?**

A) ☐ December 2019
B) ☐ April 2020
C) ☐ There are no plans as yet
D) ☐ It already has

Internet Activity

36 Which of these currently has most active accounts?

A) ☐ Facebook
B) ☐ YouTube
C) ☐ WhatsApp
D) ☐ WeChat

37 What is the single biggest source of world Internet traffic?

A) ☐ YouTube
B) ☐ General web browsing
C) ☐ Business to business data
D) ☐ Netflix

38 In last year's Great Crypto Crash, how much value did Bitcoin lose in a month?

A) ☐ 25%
B) ☐ 45%
C) ☐ 65%
D) ☐ 85%

BITCOIN·DIGITAL·DECENTRALIZED·PEER TO PEER
1 TROY OZ 999 FINE COPPER MJB MONETARY METALS

39 Last year's Marriott data breach was one of the largest in history—how many customer details were lost?

A) ☐ Up to 170 million
B) ☐ Up to 327 million
C) ☐ Up to 500 million
D) ☐ Up to 670 million

40 Which of these wasn't an Internet meme last year?

A) ☐ Chonk cat
B) ☐ Polite cat
C) ☐ Bongo Cat
D) ☐ Sweater Cat

41 Top Twitch streamer Tyler Bevins earns approximately how much a month from playing online?

A) ☐ $10,000
B) ☐ $150,000
C) ☐ $275,000
D) ☐ $500,000

42 Which cat has the biggest YouTube channel?

A) ☐ Grumpy cat
B) ☐ Maru the box cat
C) ☐ Lil Bub
D) ☐ Sam Eyebrows

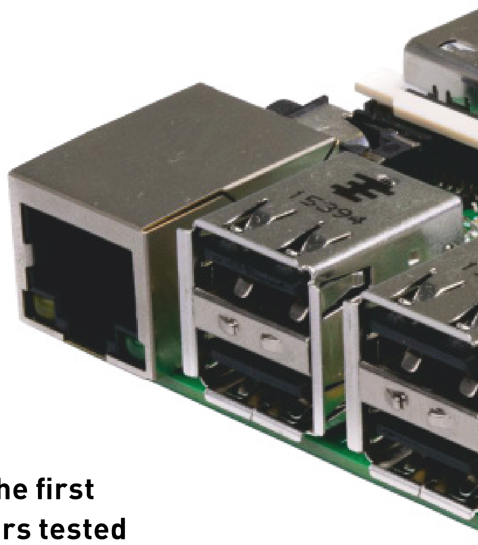
Wider World of Technology

43 During last summer's tech stock boom, which four were briefly the world's biggest companies?

A) ☐ Apple, Google, Microsoft, and Amazon
B) ☐ Apple, Microsoft, Facebook, and Google
C) ☐ Alibaba, Apple, Microsoft, and Facebook
D) ☐ Alibaba, Amazon, Apple, and Microsoft

44 Which stock then took the biggest one-day drop in history?

A) ☐ Apple
B) ☐ Intel
C) ☐ Google
D) ☐ Facebook



45 Where were the first true driverless cars tested on public roads?

A) ☐ San Francisco
B) ☐ Phoenix
C) ☐ Pittsburgh
D) ☐ Tempe

46 Approximately how many Raspberry Pis have been sold worldwide?

A) ☐ 5 million
B) ☐ 10 million
C) ☐ 20 million
D) ☐ 30 million

47 Which is the most powerful computer in the world?

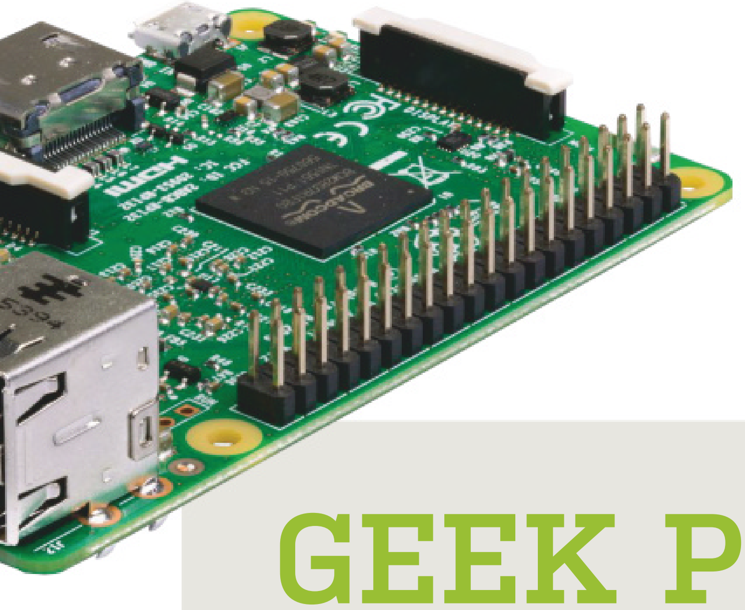
A) ☐ Sunway TaihuLight, in Wuxi China
B) ☐ Tianhe-2A, in Guangzhou, China
C) ☐ Piz Daint, in Switzerland
D) ☐ Summit, at Oak Ridge, Tennessee

48 What are the dimensions of the smallest "computer" in the world?

A) ☐ 0.1 x 0.1mm
B) ☐ 0.3 x 0.3mm
C) ☐ 0.5 x0.5mm
D) ☐ 1 x 1mm

49 **Which of these hasn't been made into a smart device yet, although it has patents filed?**

A) ☐ Toilet
B) ☐ Salt cellar
C) ☐ Wig
D) ☐ Egg tray



GEEK POINT AVERAGE

Were you honest? No Googling? Good. Add up those points and see where you are in the ranks of *Maximum PC's* Geek Quizzers: dunce or prince.

0–12 CORRECT: SUNNYDALE HIGH DROPOUT

You've somehow managed to score below the average for random guesses, which is impressive in its own way, but not a good way. Is this your magazine? A cat could score better.

13–15 CORRECT: MOS EISLEY COMMUNITY COLLEGE

This is the statistical hotspot for random guesses; you clearly have no idea what all this means. Are you actually a cat?

16–28 CORRECT: UNSEEN UNIVERSITY UNDERGRADUATE

That's better, you've clearly got some right answers on purpose, and know a thing or two. With some work, you could go far. We suspect some blind luck may have been involved, though. Keep reading!

29–35 CORRECT: CAL STATE HOGWARTS

If you truly managed this without Google's help, we're impressed. You have the makings of a proper geek. Imagine a small shiny medal: It's yours.

36–49 CORRECT: VULCAN INSTITUTE OF TECHNOLOGY

We salute you—this is first class. Your entire extended family probably uses you as free technical support. Feel that glow of pride now?

ANSWERS

Silicon City: 1]**A**, 2]**B**, 3]**A**, 4]**C**, 5]**D**, 6]**D**, 7]**C**. *Graphics Gear:* 8]**C**, 9]**B**, 10]**C**, 11]**D**, 12]**A**, 13]**C**, 14]**A**.
Storage Stuff: 15]**B**, 16]**B**, 17]**A**, 18]**D**, 19]**C**, 20]**B**, 21]**A**. *Other Hardware:* 22]**A**, 23]**C**, 24]**D**, 25]**C**, 26]**D**, 27]**B**, 28]**C**.
Operating Systems: 29]**D**, 30]**C**, 31]**D**, 32]**A**, 33]**C**, 34]**C**, 35]**A**. *Internet Activity:* 36]**A**, 37]**D**, 38]**C**, 39]**C**, 40]**D**, 41]**D**, 42]**B**.
Wider World of Technology: 43]**A**, 44]**D**, 45]**B**, 46]**C**, 47]**D**, 48]**B**, 49]**C**.

TECH PORN

Netgear Nighthawk Pro Gaming XR700

IF YOUR INTERNET connection is even vaguely important to you, a quality router is the way to go. How far you go depends largely on what sort of user you are. If, say, you fancy yourself as something of a serious gamer, you should at least consider Netgear's latest Nighthawk router, which will set you back a not-insignificant $500. That big pile of cash does get you some serious cutting-edge technology, though, and it's the kind of device that should serve all your networking needs for many, many years to come.

Apart from the incredible array of connectivity standards supported, including six Gigabit Ethernet ports and tri-band wireless support, there are plenty of other features to get excited about as well. For instance, the USB ports tucked out of sight on the left-hand side come into their own when used with the integrated Plex Media Server app. There's also support for automatic backups to Amazon Drive baked into the excellent software, which will help you avoid a few scrapes. Throw in such cleverness as being able to favor game servers that are closer to you, and allocate bandwidth to specific games/machines as needed, and this is a great option for any gamer. **–ALAN DEXTER**

NIGHTHAWK
PRO GAMING
2.4GHz
5GHz
60GHz
Quad WiFi
USB 3.0
USB 3.0
10G
1
2
3
4

1 QUAD-CORE POWERHOUSE

Netgear has eased a 1.7GHz quad-core CPU into the XR700. This means there's plenty of power for handling your 4K streams, as well as offering up an impressive range of usage data from the DumaOS-powered web interface.

2 TRI-BAND WIRELESS

Supporting 2.4GHz, 5GHz, and 60GHz bands, the XR700 gives you plenty of communication options. Admittedly, the 60GHz band is only usable in the same room, because even the thinnest walls will block it, but it's fast if you can use it.

3 WIRED WONDER

Peer around the back, and you'll discover you are spoiled for choice if you prefer physical connections, with six 1Gb LAN ports (with link aggregation) and a 10Gb Ethernet socket making sure you're covered for the future as well.

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HOW TO

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TIP OF THE MONTH

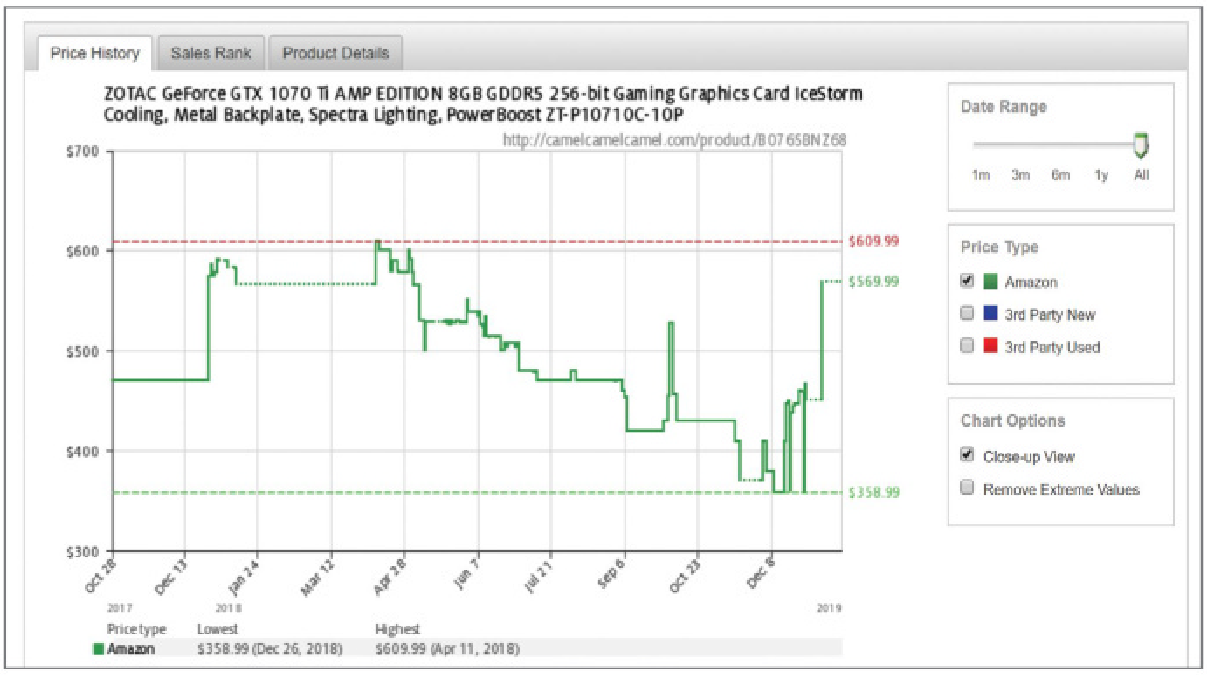

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Chart Options
☑ Close-up View
☐ Remove Extreme Values

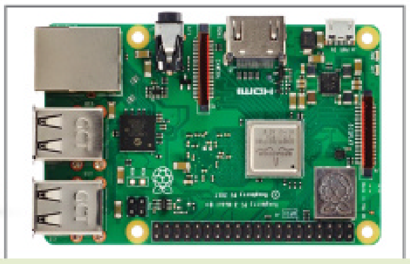
Pricetype	Lowest	Highest
🟩 Amazon	$358.99 (Dec 26, 2018)	$609.99 (Apr 11, 2018)

CHECK DEALS WITH CAMELCAMELCAMEL

Is a deal really a deal? It's a tough question. Amazon is notorious for this—one week a reseller jacks the price of an item up, only to drop it a week later to make it seem as though a deal is far better than it actually is. So, whenever you're considering a purchase, head to http://camelcamelcamel.com, paste in the URL of the Amazon item you have in mind, and it gives you a price tracker for that listing over the last year.

MAKE – USE – CREATE

56
Set up SteamVR on the cheap with the Oculus Go



64
Optimize your Raspberry Pi for better performance

68
A kick-ass gaming build for a buddy with a $1,500 budget

ZAK STOREY
CONTRIBUTING EDITOR

STRATEGIC PRICING

You can't get rid of this battered old carcass so easily—at least, not until *Maximum PC's* new son or daughter comes to claim my vacant throne. The lucrative call of freelance has been sounded, so here I am again, ready to prattle on with tirades against the loathsome trend of RGB lighting, and regale you with tales of my escapades into the first-world problems found in this beautiful land of technology.

So, the RTX 2060—what a ball ache. On the outside, it looks good: GTX 1070 Ti performance and a smudge of ray tracing, all packaged up for $150 less than that last-gen card. Pretty good deal, right? Well, no. I've been in charge of the "Blueprints" pages for the previous three issues, so I have a pretty good understanding of price trends. Suddenly, in December last year, the GTX 1070 Ti shot up by a good $150 across the board. It was a good hint that something was about to launch—something designed to catch the more scoop-happy journos off guard, thinking that it was a good deal, when in fact it was the opposite.

So, is the RTX 2060 any good? No doubt, but you could have had that level of performance for the same price last year.

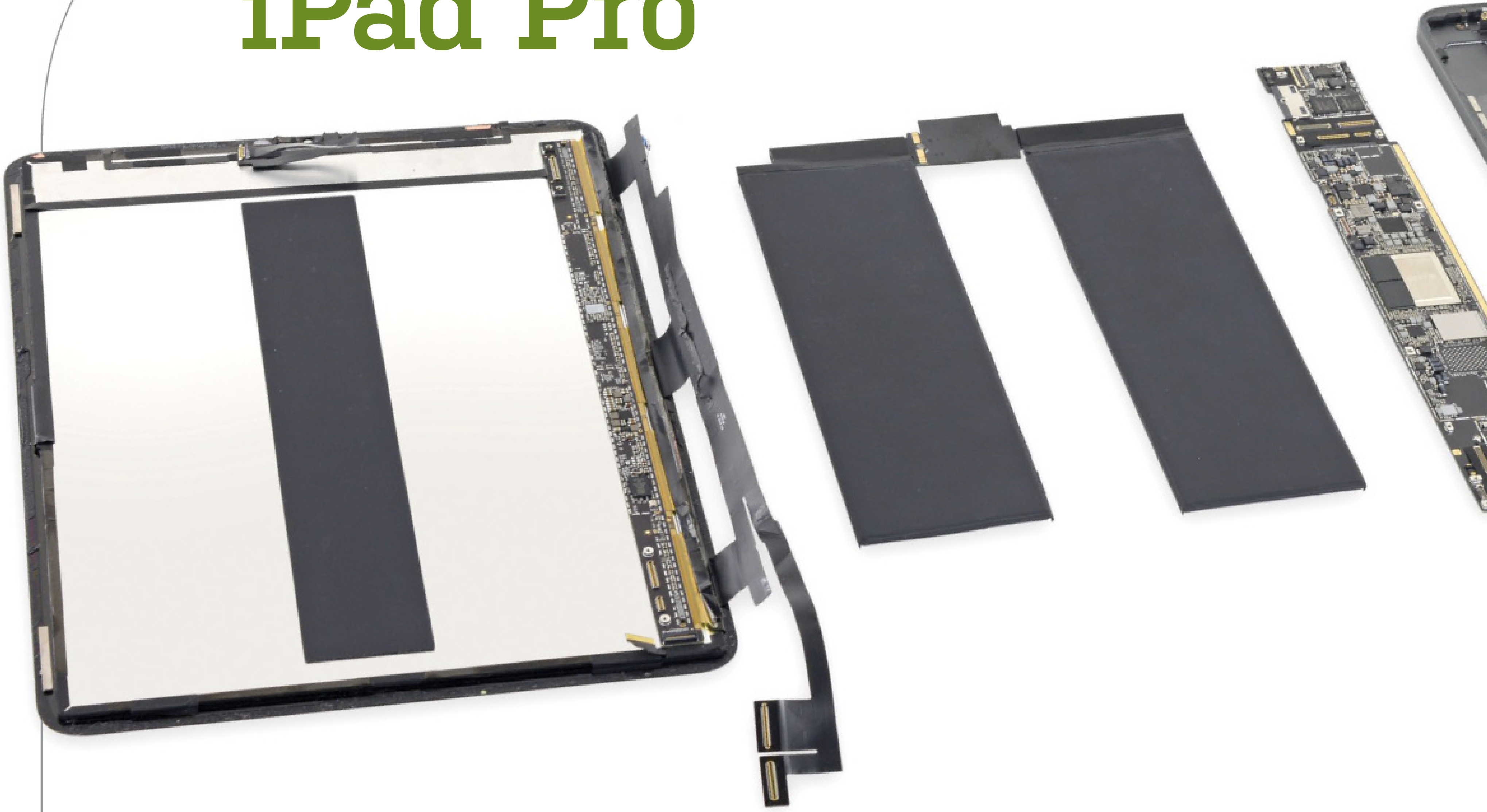
↘ submit your How To project idea to: comments@maximumpc.com

IFIXIT presents:

AUTOPSY

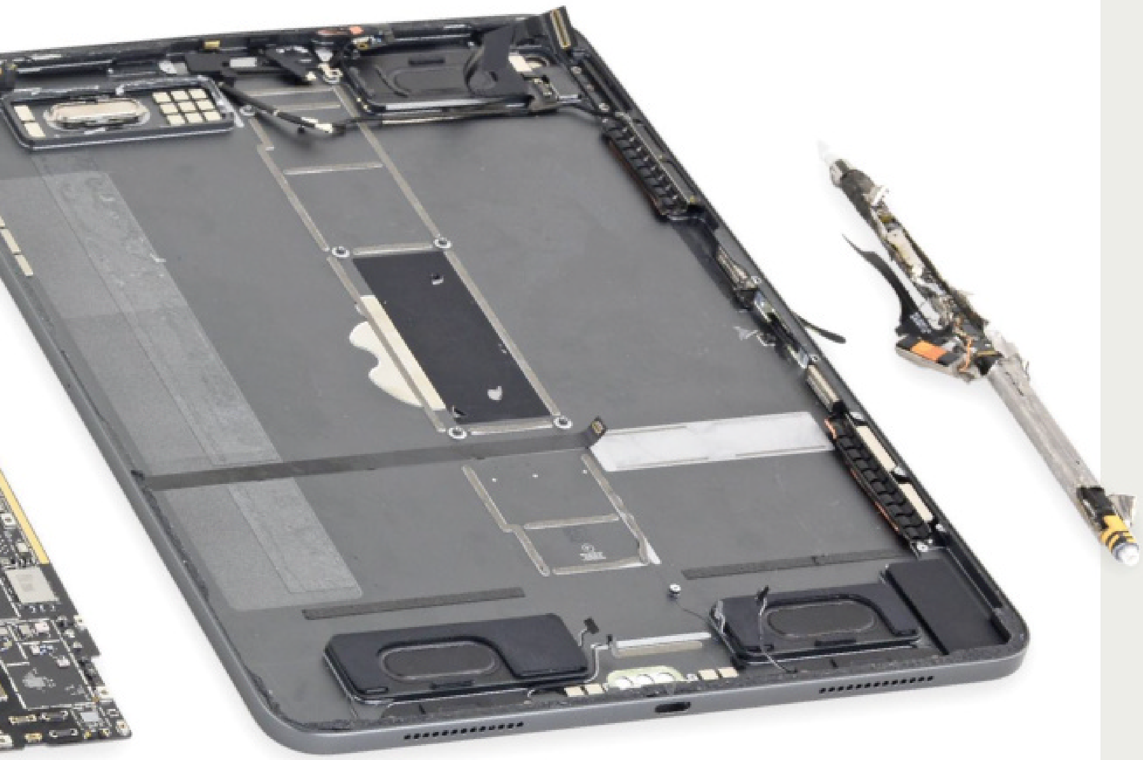
THIS MONTH WE DISSECT...

iPad Pro

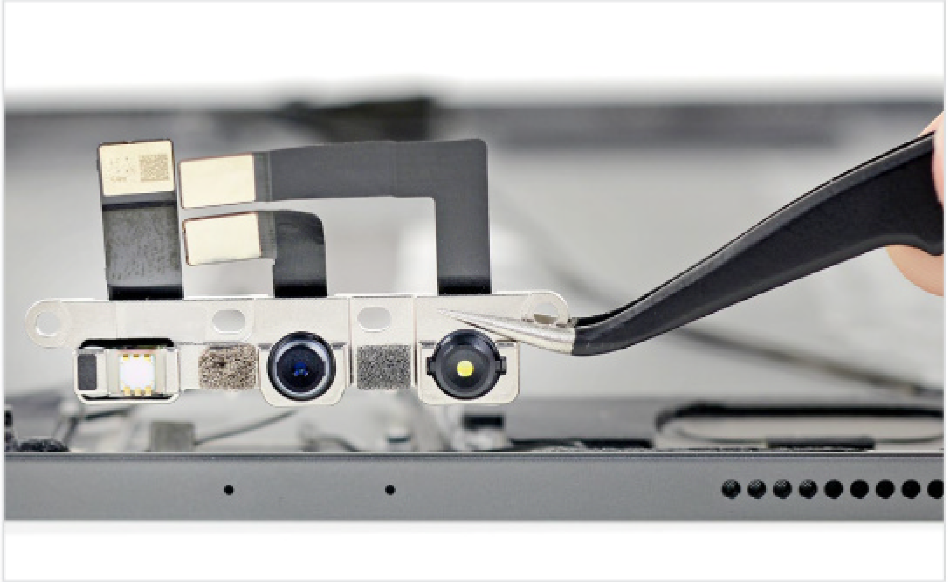


There's a lot of glue to fight with before you can get inside the new iPad Pro.

The logic board is hidden under this cover and a whole lot more glue.



Making its debut in the new iPad Pro is Face ID, as seen previously in the iPhone X.



BACKGROUND

The new 11-inch iPad Pro sports narrower bezels, curvy LCD corners, and cutting-edge silicon. This is, apparently, the iPad Apple dreamed about building from the beginning, but what we dream about is a device that's easy to repair....

MAJOR TECH SPECS

- Fully laminated, 11-inch, LED-backlit, Oxide TFT Liquid Retina display, with 2388×1668 resolution (264 ppi)
- Octa-core Apple A12X Bionic CPU, with M12 motion coprocessor, and integrated seven-core GPU
- 12MP rear camera with 4K video recording at 60fps, and 7MP TrueDepth camera with 1080p video
- Self-balancing, four-speaker audio, Face ID, five microphones, ambient light sensor, accelerometer, barometer, and 3-axis gyro
- 802.11a/b/g/n/ac dual-band MIMO Wi-Fi and Bluetooth 5.0
- 64GB, 256GB, 512GB, or 1TB of on-board storage

KEY FINDINGS

- Final notes before we dive in: No headphone jack, USB-C port (non-Thunderbolt) in place of Lightning, and a long dark oval to charge the new Pencil.
- We loved cutting through all the glue to open our first iPad, and it has never gotten old *(sarcasm alert—Ed)*. These extra-thin bezels make it even more harrowing. Heat, carve, hold your breath, and hope nothing breaks. On the plus side, the display's ribbon cables are a safe distance from the bezels—but they're also spread out in a way that makes display removal really awkward.
- Those cables aren't safe yet, as we're forced to lay the display at a weird angle and hopefully not damage anything while we disconnect them. We put our Phillips driver to work releasing both cable connectors. One thing that immediately stands out is the iPad's four woofers and four tweeters, for a total of eight speakers.
- Anxious for our first glimpse of that A12X chip, we peel away the logic board cover. Yuck—as always, the board is secured with adhesive, made even fussier by the speakers. But we're soon victorious. The logic board triumphantly emerges from the canyon betwixt the battery cells.
- We're not fans of last year's iPads, which skipped out on the stretch-release battery tabs. This year, pull tabs are back in style. Unfortunately, a huge patch of supergoop runs all the way down the left side. Sigh. Time to break out the pry tools. This iPad's powered by a 7,812mAh battery running at 3.77V, for 29.45Wh—a lot smaller than the latest Microsoft Surface Pro's 45Wh battery.
- Next to come out is the Pencil charging board, with its copper charging coils attached, but tiny capacitors and other board bits go flying in protest as we remove the shields. Last to come out is the USB-C port—which, unlike previous iPads, is fully modular. As a high-wear part, the ability to replace it independently is a nice repair win.
- Repairability score: 3 out of 10 (10 is easiest to repair). The lack of a physical home button eliminates a failure point. The battery is secured with easier-to-remove tabs and non-removable adhesive. The LCD and front panel glass are fused together—simplifying opening, but increasing the cost of repair. Gobs of adhesive hold most everything in place, making all repairs more difficult.

About iFixit

iFixit is a global community of tinkerers dedicated to helping people fix things through free online repair manuals and teardowns. iFixit believes that everyone has the right to maintain and repair their own products.
To learn more, visit www.ifixit.com.

Set Up SteamVR On the Cheap

YOU'LL NEED THIS

OCULUS GO
Along with a gamepad, VR-ready PC, and 5GHz Wi-Fi router.

VIRTUAL REALITY IS IN THE TROUGH OF DISILLUSIONMENT. Having bust through the peak of inflated expectation, early adopters are wondering why they bothered. *[Are you sure?—Ed]* But look, what's that light at the end of the valley? Could it be the slope of enlightenment out of this hellhole? If you've stuck by the motto "never an early adopter be," it might just be time to dip your toe in the VR waters.

The problem is, there's still no suitably priced PC solution. Or is there? Until recently, the Oculus Go standalone VR headset, while being quite capable, lacked anything of interest to do on it, beside watching VR movies. But what if we told you that you could play your entire Steam catalog on there, and even stream SteamVR titles? Got your interest now, right?

For $200, it's a dedicated VR device that has suddenly found its purpose in life. The cherry on top is that you can link in your Steam Controller, too, for a seamless PC VR gaming solution that won't break the bank. **–NEIL MOHR**

1 GATHER THE GEAR

Having got our hands on an Oculus Go [**Image A**] on Black Friday, our initial excitement at having an easy way to dispense all responsibility for the children for a day or two quickly evaporated once we realized there's really not that much to do with a Go, other than watching VR video. We were about to chuck it into our basement of ill-fated technology when we stumbled across the VR-streaming system called ALVR and Oculus Go sideloading.

» There are four parts to this VR option. Part one is the Oculus TV app that's pre-installed on the Go. This has been designed to enable third-party apps to project their standard screen output on to a VR canvas. Part two is a recent update to Oculus TV that added full Bluetooth controller support (and Bluetooth hacking for Steam Controller support), thus bringing full controller support into play.

» Part three is where things start to get more complex, but the recently released Android SteamLink app can be sideloaded from a PC on to the Oculus Go—we'll go into details on this—bringing your entire standard Steam library to the Oculus Go in Big Screen mode. The fourth and final part utilizes a bit of third-party code, and will stream SteamVR from your PC to the Oculus. So, all of your PC gaming needs can be catered for on a reasonably priced high-quality headset. Amazing.

» The two things you need to keep in mind are: You need a VR-capable PC (the specification isn't really that outrageous these days), and you need a 5GHz wireless router in the same room as you, for effective, glitch-free streaming.

2 SIDELOAD SOLUTION

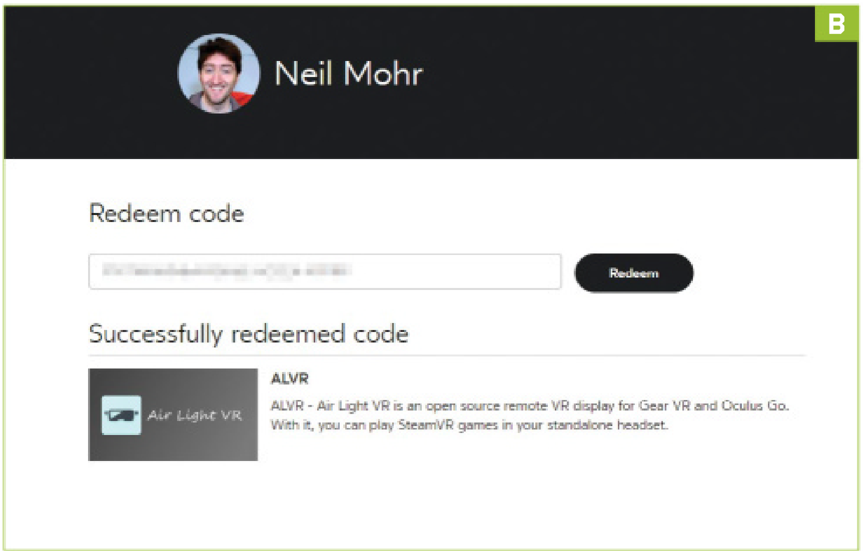
Let's play with a little Oculus Go hacking that people like to call "sideloading"—this involves installing Android APK packages over the standard Android Debug Bridge tool. If you've ever done any kind of messing around with Android devices before, it's likely you've come across this type of thing, and for once, you don't need to do any unlocking or rooting.

» First head to http://dashboard.oculus.com and register as a developer. It's free and you use your existing login to get started.

» Now switch to the Oculus app you installed on your mobile device back when you set it up. Select "Settings → Oculus Go → More Settings → Developer Mode," then click "Enable."

» You need to download and install a driver, so you're able to connect to and copy files from your PC. The Oculus Go Driver is available from https://developer.oculus.com/downloads/package/oculus-go-adb-drivers. Grab this download and extract the zip file. Inside, locate the "android_winusb.inf" file, right-click it, select "Install," and confirm you want to do so when prompted.

» Google's standard Android Debug Bridge tool, aka adb, can be found at https://developer.android.com/studio/releases/platform-tools; grab the SDK Platform-Tools for Windows. Inside the zip file, you literally just



Redeem code

[redacted]

Successfully redeemed code

ALVR

ALVR - Air Light VR is an open source remote VR display for Gear VR and Oculus Go. With it, you can play SteamVR games in your standalone headset.

CONTROLLER ISSUES

The most frustrating part of using ALVR is nothing to do with streaming, visuals, headtracking, or VR, but the controls. You can understand how the situation has arisen: The Oculus Rift, Vive, Oculus Go, and SteamVR games have all been developed with specific controls in mind.

Straight SteamVR games gave the fewest issues—*Alien Isolation* needed a little mapping to get turning on the Steam Controller—because they largely default to supporting normal gamepads. It felt like games or systems made for the HTC Vive would also largely work with the Oculus Go controller, but it lacks some of the side buttons, which will cause issues.

Oculus Rift games are a headache because they expect the dual Rift Touch controllers, while we also ran into issues with Oculus Rift games not recognizing the Steam Controller—we guess Steam was stealing the input.

For direct Oculus Go control, people suggest using a spare PlayStation Move controller and additional services that run on top of ALVR. You can find a guide to installing this at https://bit.ly/2VRBByT—we're not going to go into the details here, but it offers a Rift-level VR control solution.

need the "adb.exe" file, so extract that, then pop it on your desktop for easy access.

3 GET SET

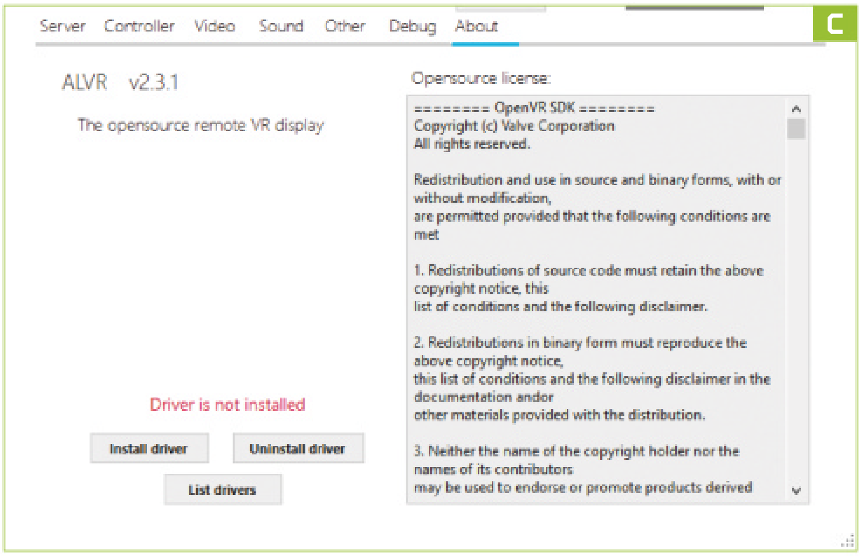
We cover other apps you might want to sideload in a boxout on page 59, but for now, we're only interested in grabbing the SteamLink app from www.apkmirror.com/apk/valve-corporation/steam-link-beta; download the arm64 (64-bit) variant (the Oculus Go utilizes a Qualcomm SnapDragon 821), and pop that on your desktop as well.

›› In the "Start Search" bar, type "command prompt" and right-click this, then select "Administrator," and choose to run. To jump to the desktop directory, where the adb.exe and the SteamLink APK should be, type `CD %USERPROFILE%\Desktop` —this is the system shortcut to "cd c:\users\<your username>\desktop," just so you know.

›› At this point, connect your Oculus Go to your PC. You can type `adb.exe devices` and it should list your headset. If it isn't, you might want to check it's on, because it has a tendency to go to sleep pretty quickly. Otherwise, check you've installed the driver, and a reboot never hurts.

›› To do the sideload, type `adb install -r "com.valvesoftware.steamlink_<verylongname>.apk"`. You can use the Tab key to autocomplete "<verylongname>" within the command prompt—just start typing `com.valve`, and press Tab.

›› When you press Return, you need to don the headset and accept a security dialog this one time; check the "Remember this PC" option. At this point, adb should copy the apk file over and install it. To use the SteamLink app, you need to go into the OculusTV app, and within this, "SteamLink" is listed at the bottom in "Other Sources." But….


C

ALVR v2.3.1

The opensource remote VR display

Driver is not installed

Opensource license:

```
======== OpenVR SDK ========
Copyright (c) Valve Corporation
All rights reserved.

Redistribution and use in source and binary forms, with or
without modification,
are permitted provided that the following conditions are
met

1. Redistributions of source code must retain the above
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list of conditions and the following disclaimer.

2. Redistributions in binary form must reproduce the
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this list of conditions and the following disclaimer in the
documentation and/or
other materials provided with the distribution.

3. Neither the name of the copyright holder nor the
names of its contributors
may be used to endorse or promote products derived
```

›› First you'll want to pair a controller, so you can play games—ideally, a Steam Controller. The official way to do this is via the Oculus app on your phone/tablet using "Controller → Add New Gamepad," but this wouldn't work for us. However, there's a way to do it using adb.

›› Connect the Oculus Go to the PC, and have a command prompt open, as before. Pop the Steam Controller into Bluetooth Pairing mode by powering it on while you hold Y. In the command prompt, type `adb shell am start -a android.settings.BLUETOOTH_SETTINGS` and press Return. Don the Oculus Go, and you'll see a Bluetooth dialog, with the Steam Controller hopefully available to pair. Select it and you're ready—don't try any of the other Bluetooth settings here, as the display will become unusable, and you'll need to run a power cycle.

4 VR STREAMING

As fun and impressive as using the SteamLink app in a VR environment is, it's not really VR, is it? We all have access to SteamVR by default; we just need a headset to view it. SteamVR is over there, our Oculus Go headset is over here…. Technology has an answer, but do you have the right hardware? Before we go into details, to get SteamVR from your PC to the Oculus Go, we're going to be using a standard wireless connection. This isn't ideal, but there's plenty you can do to experience smooth VR. The ideal solution is to have a 5GHz-capable 802.11ac router in the same room as your PC and your Oculus Go. The other element is generating the VR stream; you need a capable GPU to not only generate a high enough resolution image, but also a high refresh rate, and be able to help encode the h.265 video stream that'll be sent to the Oculus Go. The good news for cheapskates is that an Nvidia GTX 970 or AMD RX 580 is more than capable, while people with lesser hardware have reported reasonable results.

›› We're going to look at a free system called ALVR that lives over at https://github.com/polygraphene/ALVR [**Image B**]. Please bear in mind that this is still under development, but even so, we found it worked excellently with full head tracking and audio

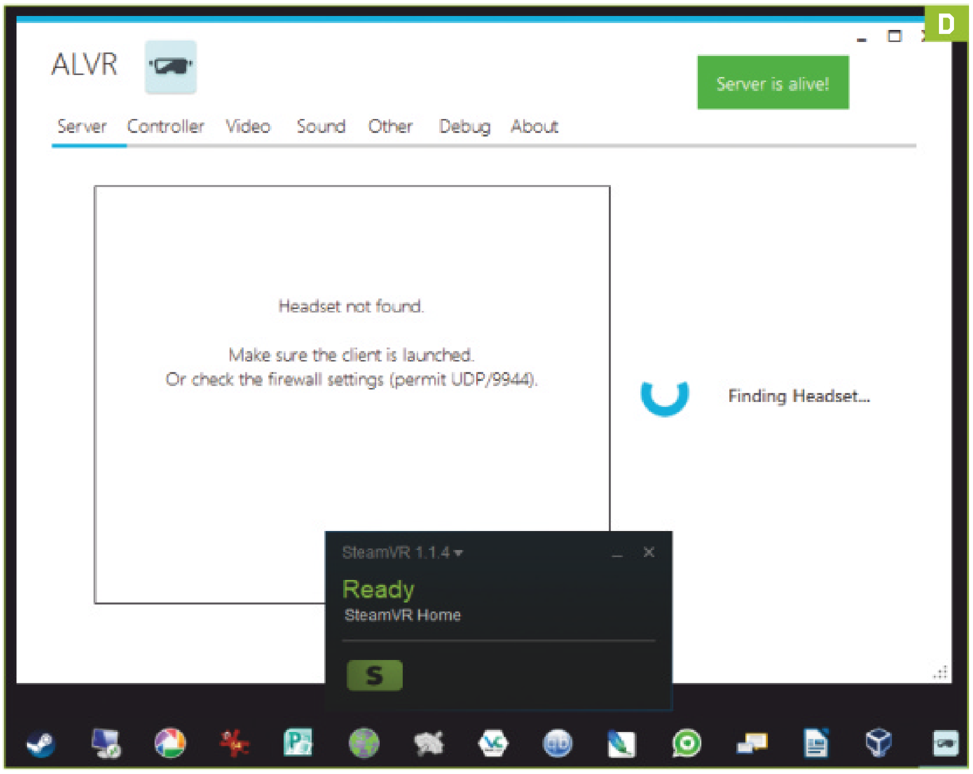
VIRTUAL REALITY GAMES

There's a big list of games you can choose from these days, with a reasonable number of decent VR experiences. Many of the best are VR spins of existing games. The main issues you'll run into are controller-based ones; either the game is hard-coded to use a specific controller you don't have, or another selection type issue will raise its annoying head. Another issue is that a game simply won't work—*Fallout 4 VR* is a prime annoyance here.

The good news is that most SteamVR games do work well, ideally with the Steam Controller. This should mean you have ample opportunity to try out a good VR experience, and perhaps commit to dedicated VR hardware down the line.

A small number of games require mods to work. Take *Alien Isolation* and the MotherVR mod from https://github.com/Nibre/MotherVR/releases—copy the DLL into the *Alien Isolation* game folder, and run the game. You might need to switch off Theater Mode in "Properties" within the normal Steam interface. Once running, you'll find a new "MotherVR" menu option to enable full in-game VR and adjust controller mappings.

For a full list of tested titles, check out https://github.com/polygraphene/ALVR/wiki/List-of-tested-VR-games-and-experiences.



Headset not found.

Make sure the client is launched.
Or check the firewall settings (permit UDP/9944).

Finding Headset...

Ready
SteamVR Home

streaming. It started off as Nvidia only, but AMD support is now in there as an experimental addition—we found it worked fine on our RX 580. The main issue is controller support; gamepads have to tie in to the PC end of things, and a Steam Controller will work fine for Steam games, and the Oculus Go controller works as a faux Vive VR controller at the Oculus Go end. We did have issues controlling Oculus games with the Steam Controller, but a standard gamepad is fine.

5 START THE STREAMING

Before we can continue setting things up, there's some downloading to do. The first job is to add SteamVR to your PC. In Steam, head to "Library → Tools," locate the "SteamVR" entry, and install it—it's around 1.5GB. If this is the first time you've used SteamVR, you should run it once it's downloaded, so it can complete its installation.

» It's not essential, but the Windows Oculus Rift app is another source of PC-based games you can take advantage of, plus it helps us show how to add and patch third-party games to the ALVR system. As we're using SteamVR, all your existing SteamVR games are already available and work. The Revive tool, which we'll come to, also adds Oculus Rift games, so they're listed as part of your SteamVR library. Add the Windows Oculus Rift app from https://oculus.com/setup. This is currently around 5.2GB, so start that fetching, and we can get on with some other tasks.

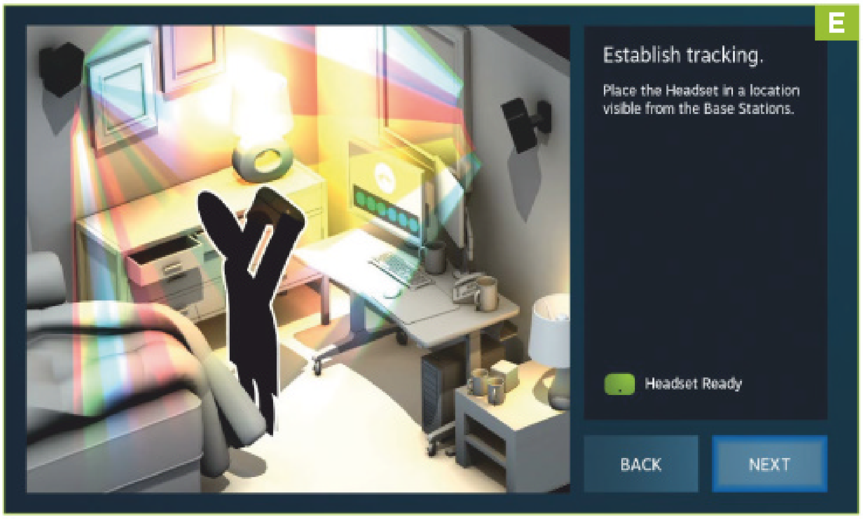
» To add ALVR to the Oculus Go itself, you need to get an app key from https://alvr-dist.appspot.com. Copy this, then head to https://secure.oculus.com/redeem-code. Log in—if you're not logged in already—and use the key here. You can also pop it in the Oculus Go smartphone app, as an alternative.

» We can now start setting up the ALVR server [**Image C**], so go grab its setup.exe from https://github.com/polygraphene/ALVR/releases—at the time of writing, this was v2.3.1. Install and run it, switch to the "About" tab, and install the driver.

6 REVIVE AND SURVIVE

Next, grab the installer v1.1.6 for the Revive project from https://github.com/LibreVR/Revive/releases/tag/1.1.6. This enables non-Oculus systems to run all Oculus Rift VR titles. It's rather an old release, but newer versions may not work, so stick to v1.1.6.

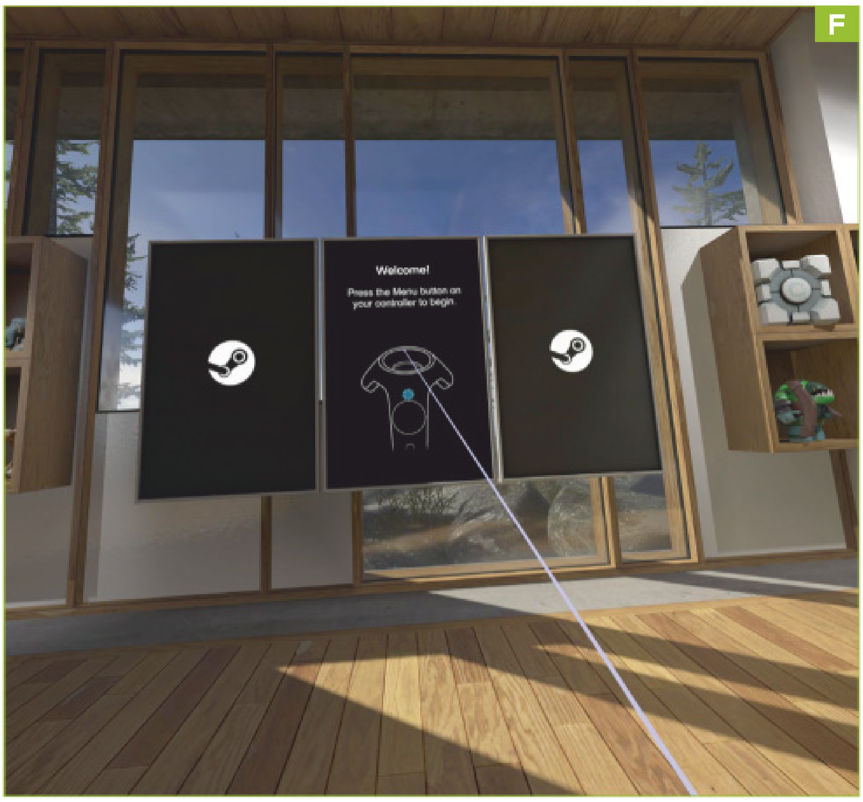
» Hopefully, by now you've got the Windows Oculus app, so install that, log in, and run through the setup. Unless you have Oculus Touch Controllers, ensure any



Establish tracking.

Place the Headset in a location visible from the Base Stations.

Headset Ready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games you download will work with a straight gamepad. One that's recommended for trying out the system is *Lucky's Tail*. So grab that (it's another 2.2GB download), and we can carry on trying this out [**Image D**].

» We're almost ready to go, but first you need to install the ALVR app on the Oculus Go itself, else the PC-based server won't have anything to connect to. Fire up the Oculus Go, head to "Library → Apps → Not installed," get ALVR, and start it.

» Back on your PC, run ALVR; this also starts SteamVR automatically. We'll mention at this point that we received a "critical component missing" error from Steam, which relates to us running Steam from a separate drive—the linked support page helped rectify that, editing the incorrect paths in the "user/AppData/Local/openvr" file. Hopefully, you won't have the same problem. Click the "Start Server" button, and ALVR starts looking for the ALVR Oculus GO app.

» With the ALVR server working and SteamVR ready, a message on the Oculus Go ALVR app should prompt you to click "Connect" on the Windows-based ALVR server—do so. Welcome to SteamVR Home [**Image E**]!

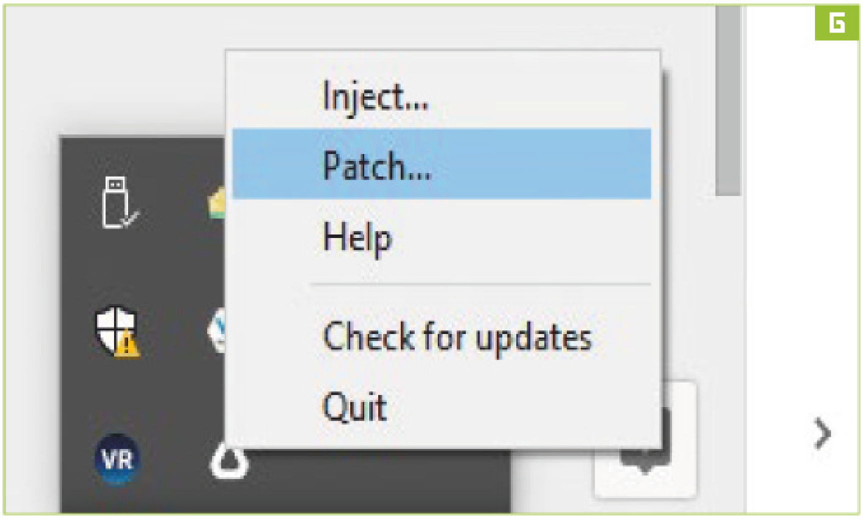
7

FINAL STEPS

The Oculus Go controller will appear as the standard Vive controller in VR, and largely works the same. Your head will appear to be on the floor at this point, so on the Oculus controller, click the "Home" button to open the SteamVR menu, and at the bottom, click the "Steam Desktop" button—it's your Windows desktop, but in VR. In the SteamVR dialog, click the "Room Setup" link (this is also an entry in your SteamVR library). You'll want to select standing setup, and set the headset height to about 36 inches, which should make things more comfortable [**Image F**].

» Want to bring Oculus Rift games to the party? Run Revive—this enables you to patch a game's executable, so it'll run across different VR systems without complaint. For us, that means SteamVR and any Oculus titles appear in our Steam Library. You can add a shortcut to the patched version on your desktop if you like, too. Using *Lucky's Tail* as an example, right-click the Revive icon in the notification area, select "Patch" [**Image G**], and locate the game—C:\Oculus Apps\Software\playful-luckys-tale. When you start SteamVR, you'll find a link in your Library.

» The big issue you'll run into is controller support—see the boxout on page 57 for options for supporting Rift games. With a little fiddling, configuration, and experimentation, most games can be convinced to work, but from a video and audio perspective, the whole experience was flawless for us. ⏻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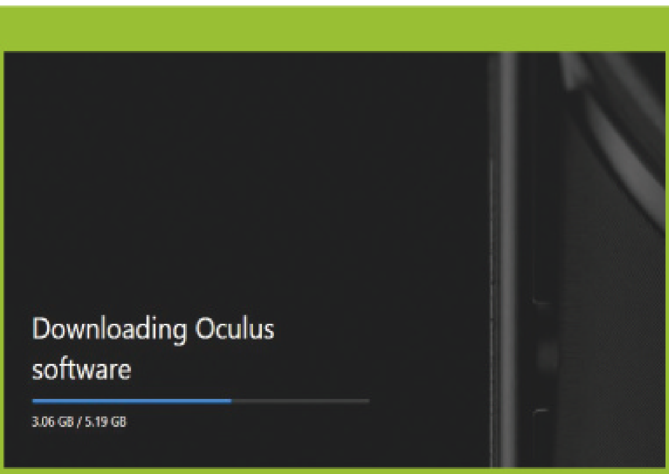


Downloading Oculus software

3.06 GB / 5.19 GB

SIDELOAD APPS

It might seem that the sideloading feature we've covered isn't that useful, but alongside hacking the Bluetooth controller support, there's a host of apps out there, which can be sideloaded on to the Oculus Go to help you have a little more fun with it. Just for starters, the default built-in Plex and Netflix apps are not as up-to-date as the official releases, so you can improve your experience by grabbing the appropriate APK from the likes of www.apkmirror.com/apk/netflix-inc/netflix.

There's also a number of homebrew games out there that Oculus will never support. Take the open-source release of the original *Quake*—someone's given it the VR treatment at https://github.com/DrBeef/QuakeGVR/releases. The frame rate comes and goes, but, oh, the nostalgia!

Talking of nostalgia, another app you should consider sideloading is the Virtual Boy emulator (https://github.com/CidVonHighwind/VirtualBoyGo/releases), which helps you relive the headtracking-free days. Finally, for those with Amazon Prime accounts, you can gain access to your Amazon Prime Video with the addition of the right app from https://apkpure.com/amazon-prime-video/com.amazon.avod.thirdpartyclient.

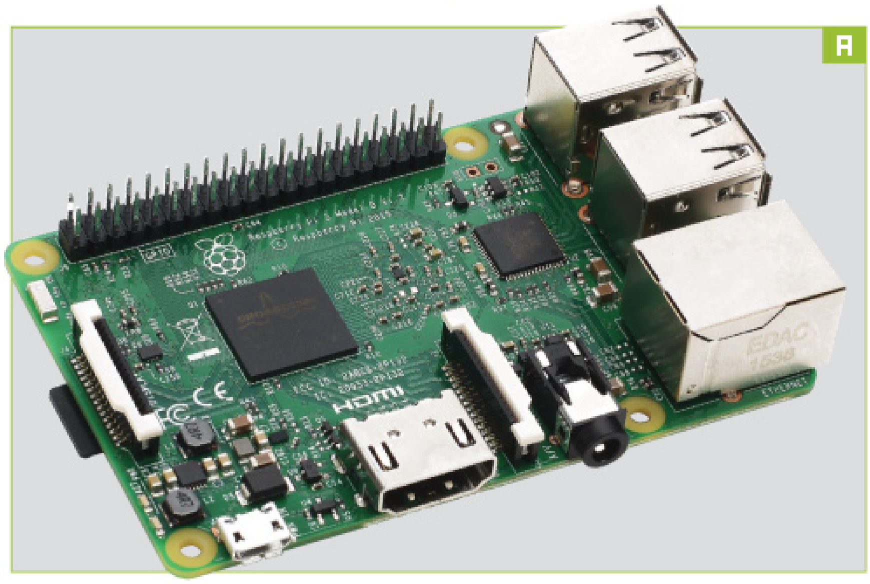
Steam Up Your Raspberry Pi

YOU'LL NEED THIS

RASPBERRY PI 3 MODEL B OR B+
You'll want the raw power of the latest Pi to make your game streaming a reality.

VALVE'S STEAM LINK was an odd little device. Frequently discounted to just a couple of dollars, and much-maligned for producing inconsistent results, the now-discontinued black box aimed to beam your games from your desktop PC, presumably residing in a dirty corner of your home, to your living room TV. Not a new concept, certainly—you can do it with an Xbox or PlayStation, or with tech such as GeForce Go, or even Steam from PC to PC—but a damn convenient one if you have a library full of Steam games and an insatiable yearning for your couch.

Good news, then: Steam Link is dead, but long live Steam Link, now reborn as a chunk of Linux code, suitable to run on a Raspberry Pi 3. Yes, you'll be investing more—you need a Raspberry Pi 3B or 3B+ ($35, plus all the other bits you require)—but once it's hooked up, you'll get the same effect, and there's nothing to stop you installing other stuff on your Pi to give it a second job. RetroPi, anyone? Plex or Kodi? It's up to you. **–ALEX COX**



1 PREPARE YOUR PI

You absolutely need a Raspberry Pi 3B or 3B+ [**Image A**]. We didn't try this on a Pi Zero or a previous version of the main Raspberry Pi branch, because we weren't feeling masochistic enough—it's unlikely to work at all, but if that's all you've got, you're welcome to try it. You also need an Ethernet connection (we'll come to this later on) and, at least initially, a keyboard and mouse, before you replace them with a controller. A large SD card isn't a primary requirement (we installed on an 8GB card we had lying around), but if you want to do more with your Steam Link box, you'll want to give yourself a little more breathing room. Lastly, don't skimp on the power supply: You need something that puts out at least 2.5A, because if your Pi doesn't get the relevant juice, it'll descend into a mess of glitches—consider, also, adding a heatsink kit to your box to prevent it frying itself.

2 GET CARDED

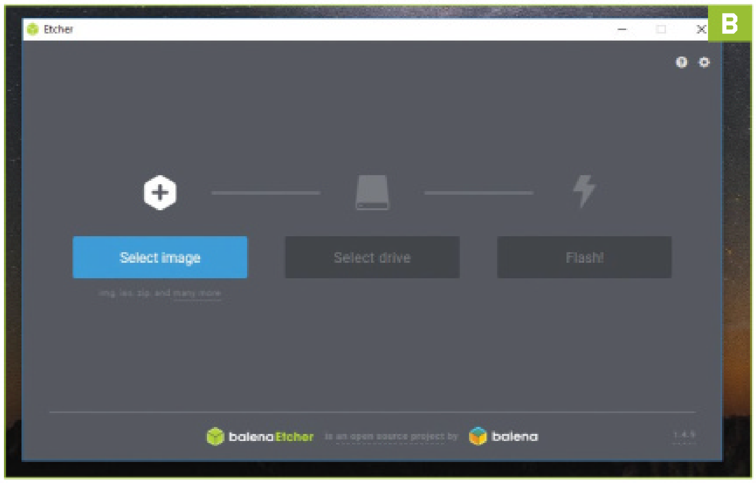
Unlike some single-use Raspberry Pi cases, there's no special distro to install on your SD card—the Steam Link app installs and runs on top of Raspbian Stretch, the Pi's default OS. Download the desktop version from www.raspberrypi.org and unzip it, then grab Etcher from www.balena.io to get the OS image on to your SD card. Insert the card into your reader, run Etcher [**Image B**], drag and drop the ISO image on to the window, and proceed with the writing procedure, as long as you're sure you've extracted everything you need from that SD card, as this is a 100 percent destructive procedure. When the write's done, pop the card into your Raspberry Pi and boot up—it should drop you straight to Raspbian's Pixel desktop.

3 INSTALL STEAM LINK

Open up a terminal (the icon is at the top of the screen) and type `sudo apt update` to make sure your OS install is as current as it can be, and to ensure Raspbian's knowledge of its repositories (the online locations it draws software from) is up to date. Then type `sudo apt install steamlink` to download the whole thing and install it automatically. That's the installation process done with—you should see a Steam Link icon appear on your desktop, and the program's ready to run. You can now either double-click that icon, or run `steamlink` within the terminal window.

4 FIRST RUN

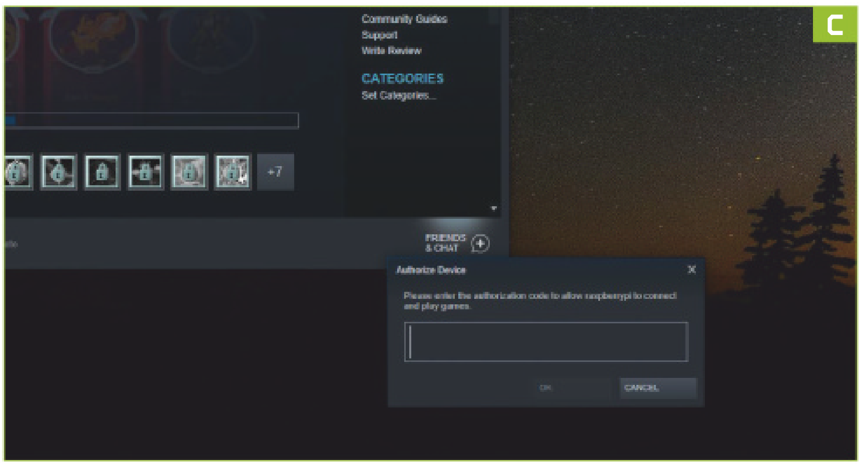
If you have a controller, you can plug it in and configure it now—Steam Link on the Raspberry Pi supports Xbox 360, Xbox One, and PlayStation 4 controllers, as well as the Steam Controller as long as you're using the wireless dongle. We recommend going wired in order to cut out that tiny amount of latency caused by wireless links, given that you're already going to be dealing with (at least on the Beta we tested) around 20ms network and rendering latency, and whatever your TV's picture processing engine puts on top—depending on the TV, this could be anywhere from 6ms to 30ms, provided you're in game mode, and far worse than that



RUNNING AUTOMATICALLY

F007348
OnOff SHIM
BTN

If you're dedicating a Raspberry Pi entirely to running Steam Link, and you're mostly aiming for couch gaming, it might make sense to remove the need to manually launch the program when the Pi powers on—that way, you can do away with the mouse and keyboard entirely. Raspbian Stretch has a number of methods to run apps automatically, but editing "/etc/rc.local" is the simplest way to do it. Open up a terminal, and run `sudo nano /etc/rc.local` to begin tweaking, then make a new line just above `exit 0`. Add the text `sudo -u pi /usr/bin/steamlink &`—the ampersand is important, because without it, the Pi's boot process won't properly complete—then save the file by hitting Ctrl-X followed by Y. Reboot your Pi, and it should jump straight into Steam Link. Now the only problem is shutting down—there's no way to do it gracefully with a joypad, and pulling the power risks corrupting your SD card. Consider adding a Pimoroni OnOff SHIM (around $7), which, with a little installation, works as a safe power button on the outside of the box.



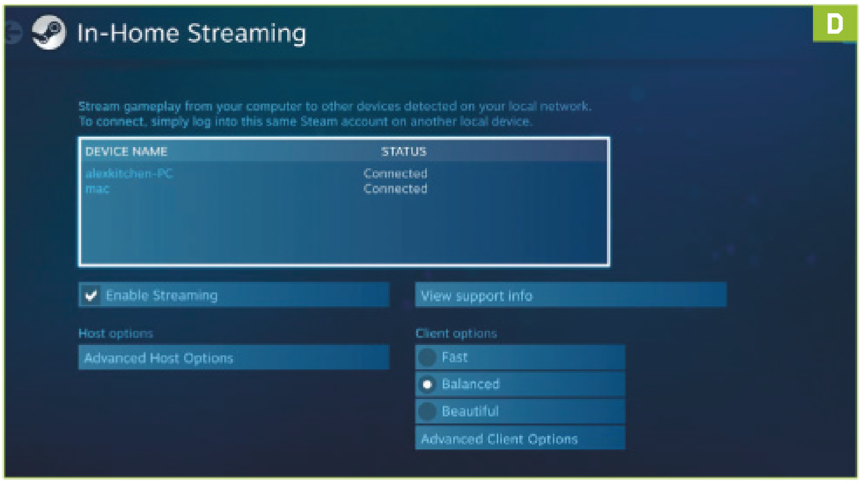
Authorize Device

Please enter the authorization code to allow raspberrypi to connect and play games.

without. Once that's set up, you're asked to perform a network test. If you're connected by Wi-Fi on a standard Pi 3B—which is 2.4GHz only—this is the point where Steam Link will shout at you. On a 3B+, you may find that 5GHz networking is actually adequate for streaming, but we wholeheartedly recommend hooking up to an Ethernet connection, both on your Raspberry Pi and the PC you're streaming from. The latency is lower, the speed is generally higher, and there's far less chance of interference causing you to drop frames.

5 CONNECT TO STEAM

Now it's time to select which Steam-running PC you want to connect to; if you're given no options at this stage, boot up your PC, and run Steam. We'd have thought that was pretty obvious. Note down the PIN given to you by Steam Link, then head back to your PC, and enter it in the box that's popped up [**Image C**]. All being well, your PC will jump into Steam's Big Picture mode and, returning to your Raspberry Pi, you'll see its screen duplicated, and the menu should be controllable by whatever input device you have hooked up to the Raspberry Pi. Bad news if you were hoping to use your PC for something else while others game, because that isn't how Steam Link works; it locks up your main machine for the whole time you're streaming, in the same way as Steam's standard In-home Streaming mode does.



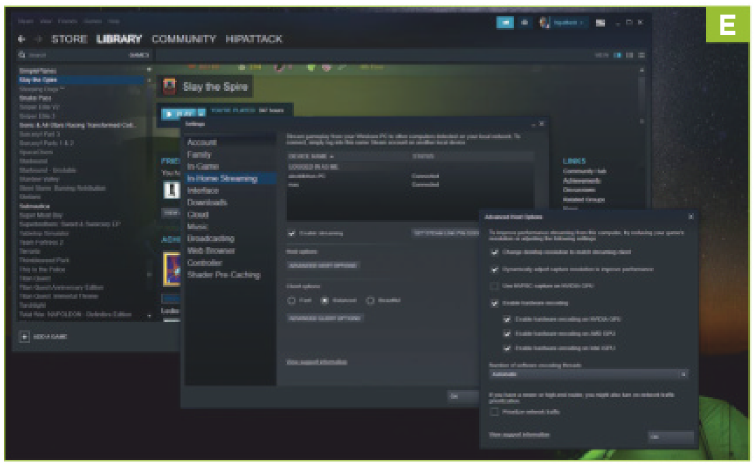
Stream gameplay from your computer to other devices detected on your local network.
To connect, simply log into this same Steam account on another local device.

DEVICE NAME	STATUS
alexkitchen-PC	Connected
mac	Connected

☑ Enable Streaming

Host options

Client options
○ Fast
● Balanced
○ Beautiful



6 BETTER CONNECTIONS

As they say, your results may vary. It's entirely possible that your network holds up well and your Steam Link experience is positive. Don't count on it, though—these things don't always work as planned. There are ways to get better results beyond using a wired connection. Dig around your network and stop those upload-heavy peer-to-peer connections that you definitely don't have running; delve into your router's settings and, if possible, assign some priority to the machines on either end of your Steam Link equation, using QoS management tools; close whatever you can on the PC you're linking to, in order to give it the maximum resources to render your stream. This can include Nvidia hardware encoding—you might want to turn off ShadowPlay and Gamestream, because these can actually make Steam's encoding worse.

7 STEAM SETTINGS

Steam itself can be configured to make a decent difference to streaming. Tweaking your connection's settings to drop a little graphical fidelity is highly advised—on your Pi, head to the cog icon, select "In-Home Streaming," and opt for "Fast" or "Balanced" if the Beautiful mode is glitching out [**Image D**]. On your host PC, select "Steam → Settings → In Home Streaming → Advanced Host Options" [**Image E**], and try flicking some of the switches there. Don't forget to set your game to the lowest resolution you find acceptable. From your couch, 720p won't seem so painful. ⏻

Keep All Your Passwords Safe

YOU'LL NEED THIS

BITWARDEN ACCOUNT
Sign up for free at
https://bitwarden.com.

PASSWORD MANAGERS ARE DIME A DOZEN THESE DAYS, but BitWarden is an overlooked gem that deserves more attention. It has all the features you'd expect in a good password manager—easy and convenient to use, but locking your sensitive data away in a highly encrypted vault. It offers two-factor authentication (2FA) for extra security, and makes it easy to generate new random secure passwords for all your accounts. It also works across a wide range of devices.

What we love about BitWarden is that it's open source, so more transparent than other password managers. It's also free—no key features are locked away behind a paywall, although premium tiers exist if you need something extra or want to support it financially. We'll explore its core features here, and get you started protecting your online accounts. –**NICK PEERS**

1 SIGN UP FOR FREE ACCOUNT

Open your web browser and go to https://bitwarden.com. Click "Create Account," and provide your email address, name, and a Master Password [**Image A**] to unlock everything else (length is more important than randomness when creating a strong Master Password—for example, "1Penzance4Harrison8Westerly"). If you use the "Password hint" field, make sure it's a clue only you can guess. Click "Submit."

2 INSTALL BITWARDEN

Next, log in through BitWarden's web interface at https://vault.bitwarden.com, and click "Send Email" to verify your email address and unlock all the features. Once done, click the icon in the top-right corner, and choose "Get the Apps." Install the Windows app to manage sites outside your browser, plus the appropriate plugin for your web browser.

3 ADD YOUR FIRST PASSWORD

Look for the BitWarden icon in the browser toolbar, and click it to open a pop-up window. Log in to your account, so the icon turns blue, then close the pop-up for now. Navigate to your first website, and log in as normal—you may see a prompt to add the password to BitWarden (in which case do so); if not, click the "BitWarden" button to add it manually [**Image B**].

4 IMPORT PASSWORDS

If you're switching from another password manager, export your passwords in CSV format—if the contents open in a separate browser window, select all the data, then copy and paste it into a text editor. Log in to https://vault.bitwarden.com in your browser, and choose "Tools → Import Data." Select the import type and file, or paste the data from your text editor. Click "Import Data" [**Image C**].

5 TIGHTEN SECURITY FURTHER

Each time you open your browser, you'll see a padlock next to the BitWarden logo—this indicates you need to enter your master password to unlock the vault. Click "Settings" to change this behavior under "Lock Options," if you wish [**Image D**]. If you use two-factor authentication to protect other accounts, choose "Two-step Login" to set this up for BitWarden, too.

6 LOGINS MADE EASY

Now, whenever you visit a website where you've stored your password, you'll see a number appear next to the BitWarden app icon, indicating the number of available logins for that site. Open the plug-in and click your desired login, which should autofill the username and password fields for you. You can also copy your credentials to the clipboard, plus view and edit the login details.

7 UPDATE YOUR PASSWORDS

If you have a weak password for a website, now is the time to update it. Log in to the site, and navigate to the section where you can update your password. Enter the current password, if prompted, then open the plug-in and click "Generator" to generate a new random password. Click "Copy Password" and update the password [**Image E**]. If you're not prompted to update it, do so manually.

8 STORE MORE SENSITIVE INFORMATION

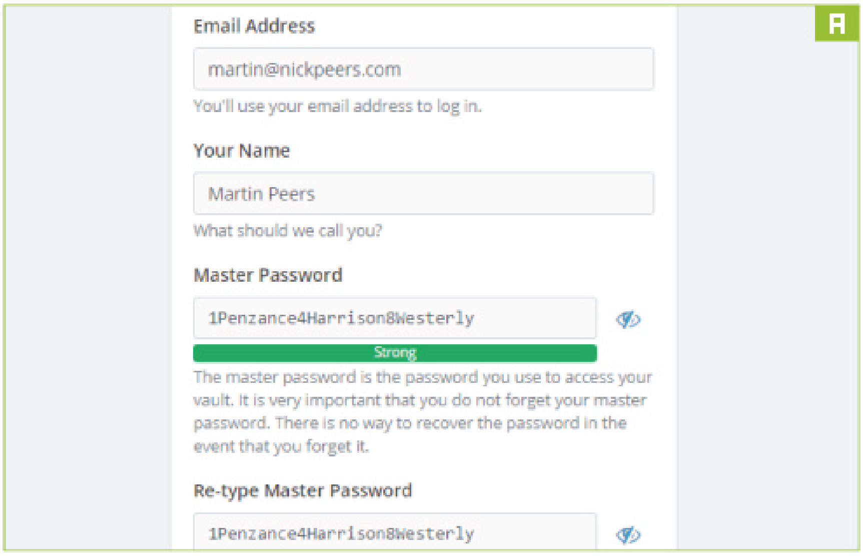
Open the plug-in and click "My Vault." You can add additional items here to speed up web browsing: Click "Card" to store credit card details [**Image F**], and "Identity" to record personal details to quickly fill in forms. Store generic information under "Secure Notes." Add as little or as much information as you wish—we recommend activating 2FA before storing this kind of data in your vault.

9 CHECK FOR BREACHES

BitWarden can be used to alert you to potential data breaches that might have exposed your password. Log in to the web vault and choose "Tools → Data Breach Report." Enter one of your usernames or email addresses, and click "Check Breaches." If any are found, BitWarden displays information about them [**Image G**]. If you still use that site, now's the time to change your password.

10 WEB BROWSING MADE EASY AND SECURE

Now you've tightened browser security and made things easier for yourself, it's time to install BitWarden on all your other computers and mobile devices—including Apple and Android phones and tablets [**Image H**]. Everything is free, and your vault is securely synched via the cloud using end-to-end encryption, to prevent it falling into the wrong hands.



Email Address

martin@nickpeers.com

You'll use your email address to log in.

Your Name

Martin Peers

What should we call you?

Master Password

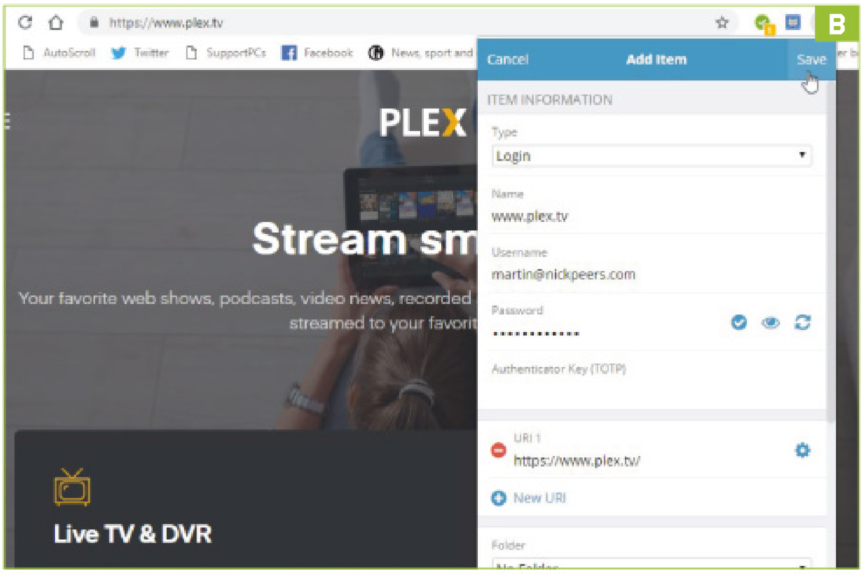
1Penzance4Harrison8Westerly

Strong

The master password is the password you use to access your vault. It is very important that you do not forget your master password. There is no way to recover the password in the event that you forget it.

Re-type Master Password

1Penzance4Harrison8Westerly


B
https://www.plex.tv
AutoScroll
Twitter
SupportPCs
Facebook
News, sport and
PLEX
Stream sm
Live TV & DVR
Cancel
Add Item
Save

Your favorite web shows, podcasts, video news, recorded streamed to your favorit

ITEM INFORMATION

Type: Login

Name: www.plex.tv

Username: martin@nickpeers.com

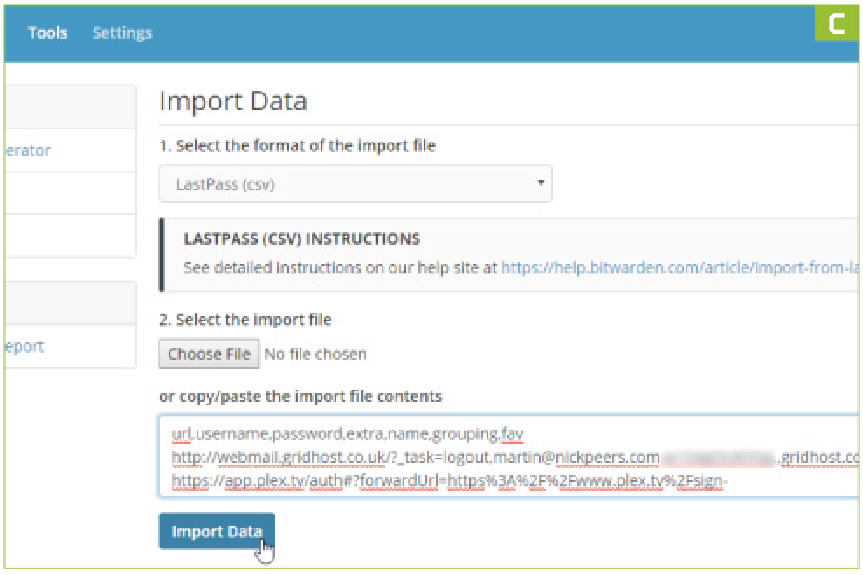
Password: •••••••••••••

Authenticator Key (TOTP)

URI 1: https://www.plex.tv/

New URI

Folder


C
Tools
Settings
erator
eport

Import Data

1. Select the format of the import file

LastPass (csv)

LASTPASS (CSV) INSTRUCTIONS

See detailed instructions on our help site at https://help.bitwarden.com/article/import-from-l

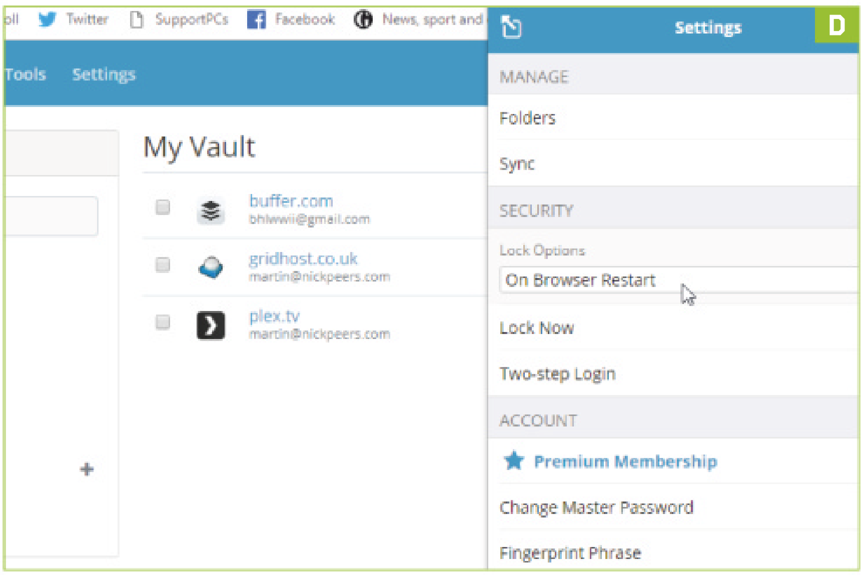
2. Select the import file

Choose File No file chosen

or copy/paste the import file contents

```
url,username,password,extra,name,grouping,fav
http://webmail.gridhost.co.uk/?_task=logout,martin@nickpeers.com [redacted] ,gridhost.co
https://app.plex.tv/auth#?forwardUrl=https%3A%2F%2Fwww.plex.tv%2Fsign-
```

Import Data


D
Twitter
SupportPCs
Facebook
News, sport and
Tools
Settings
Settings

My Vault

buffer.com — bhlwwii@gmail.com

gridhost.co.uk — martin@nickpeers.com

plex.tv — martin@nickpeers.com

MANAGE

Folders

Sync

SECURITY

Lock Options: On Browser Restart

Lock Now

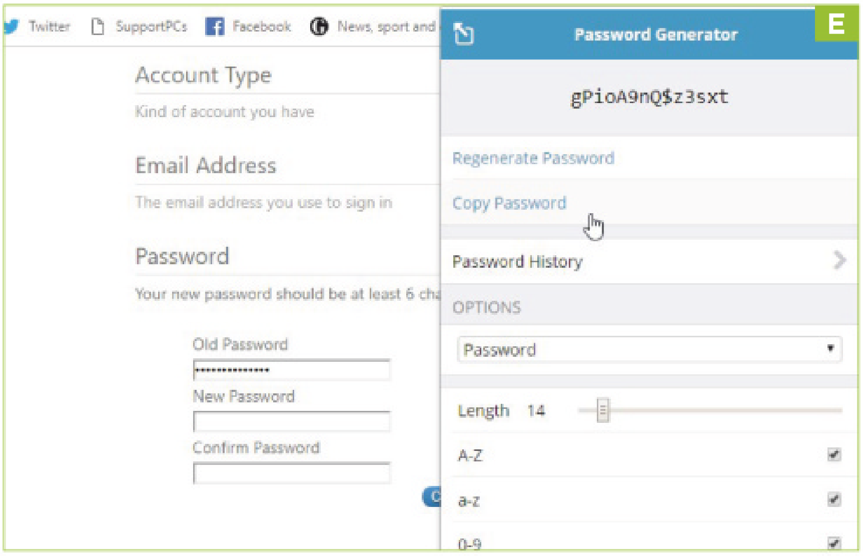
Two-step Login

ACCOUNT

Premium Membership

Change Master Password

Fingerprint Phrase


E
Twitter
SupportPCs
Facebook
News, sport and
Password Generator

Account Type

Kind of account you have

Email Address

The email address you use to sign in

Password

Your new password should be at least 6 cha

Old Password: ••••••••••••••

New Password

Confirm Password

gPioA9nQ$z3sxt

Regenerate Password

Copy Password

Password History

OPTIONS

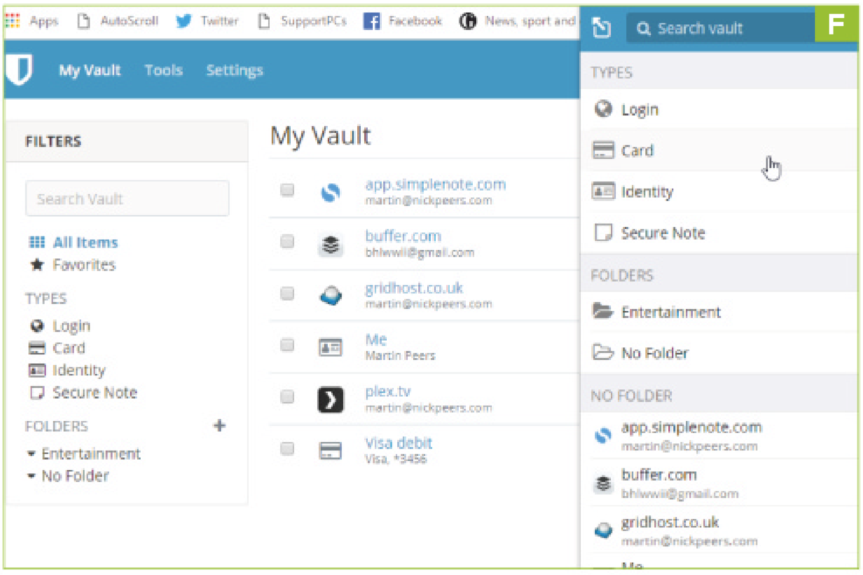
Password

Length 14

A-Z ☑

a-z ☑

0-9 ☑


F
Apps
AutoScroll
Twitter
SupportPCs
Facebook
News, sport and
Search vault
My Vault
Tools
Settings

FILTERS

Search Vault

All Items

Favorites

TYPES

Login

Card

Identity

Secure Note

FOLDERS

Entertainment

No Folder

My Vault

app.simplenote.com — martin@nickpeers.com

buffer.com — bhlwwii@gmail.com

gridhost.co.uk — martin@nickpeers.com

Me — Martin Peers

plex.tv — martin@nickpeers.com

Visa debit — Visa, *3456

TYPES

Login

Card

Identity

Secure Note

FOLDERS

Entertainment

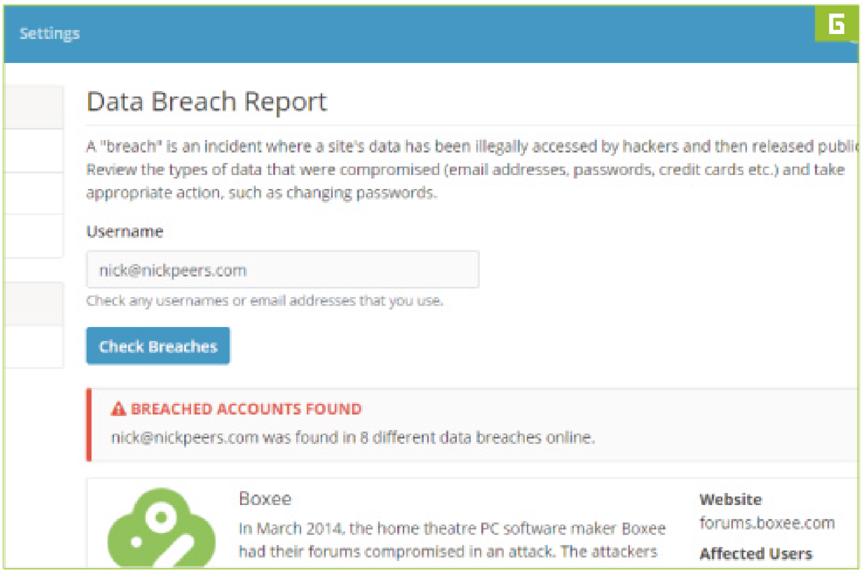
No Folder

NO FOLDER

app.simplenote.com — martin@nickpeers.com

buffer.com — bhlwwii@gmail.com

gridhost.co.uk — martin@nickpeers.com



Data Breach Report

A "breach" is an incident where a site's data has been illegally accessed by hackers and then released publi Review the types of data that were compromised (email addresses, passwords, credit cards etc.) and take appropriate action, such as changing passwords.

Username

nick@nickpeers.com

Check any usernames or email addresses that you use.

Check Breaches

BREACHED ACCOUNTS FOUND

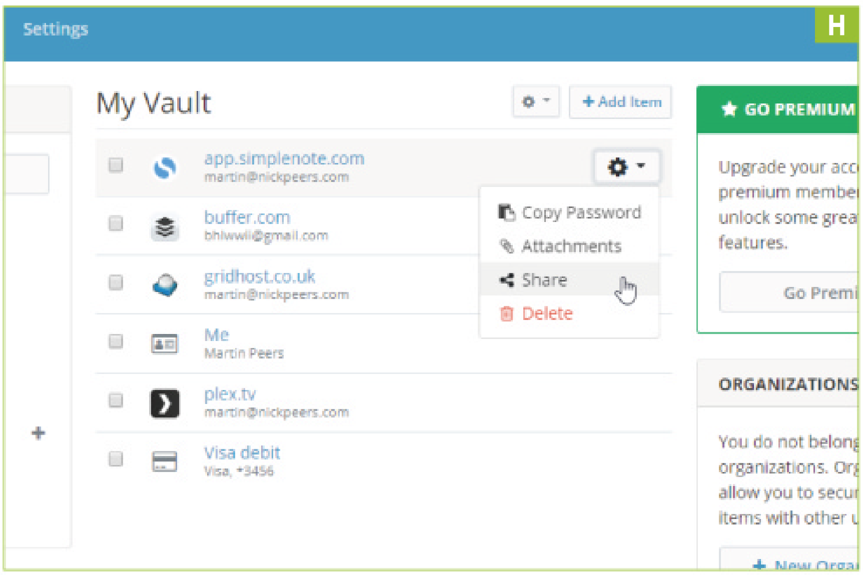
nick@nickpeers.com was found in 8 different data breaches online.

Boxee

In March 2014, the home theatre PC software maker Boxee had their forums compromised in an attack. The attackers

Website: forums.boxee.com

Affected Users


H
Settings
Add Item
GO PREMIUM
Go Premi
New Orga

My Vault

app.simplenote.com — martin@nickpeers.com

buffer.com — bhlwwii@gmail.com

gridhost.co.uk — martin@nickpeers.com

Me — Martin Peers

plex.tv — martin@nickpeers.com

Visa debit — Visa, *3456

Copy Password

Attachments

Share

Delete

Upgrade your acc premium membe unlock some grea features.

ORGANIZATIONS

You do not belong organizations. Org allow you to secur items with other u

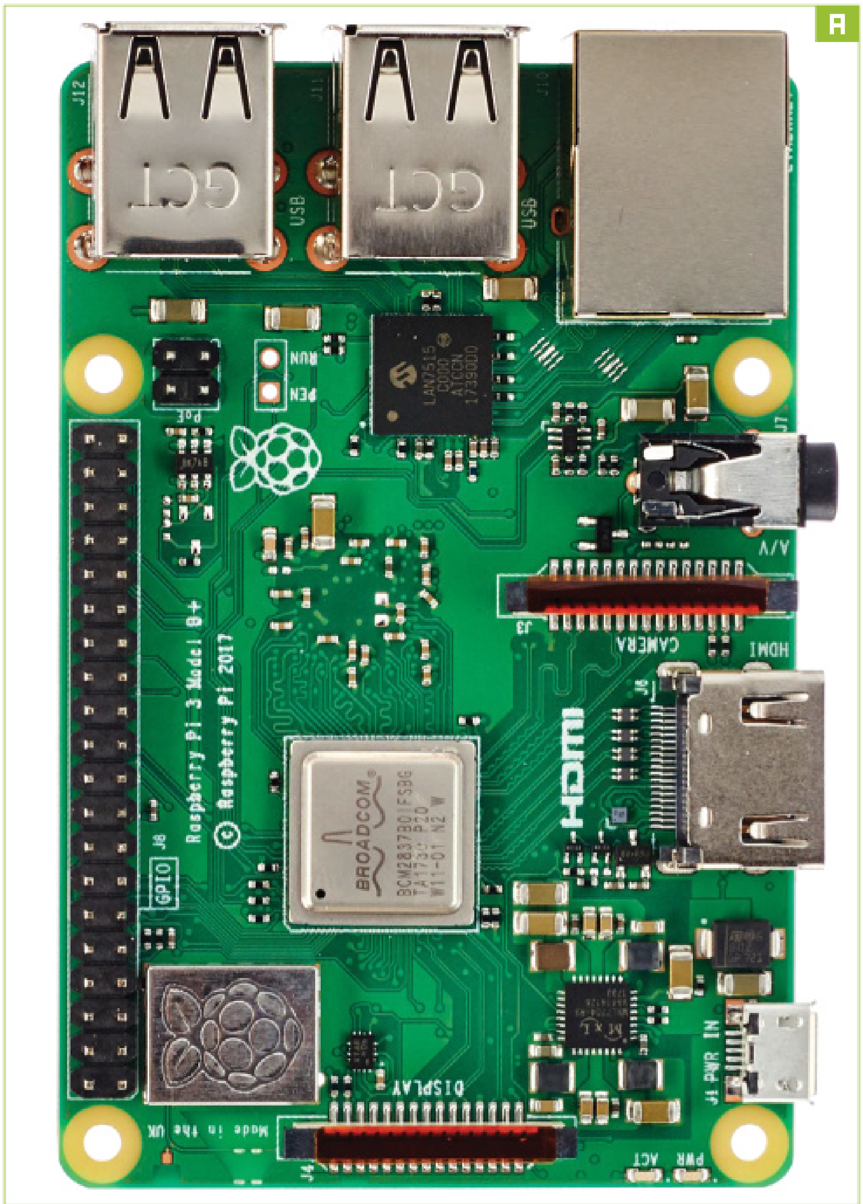
Optimize Your Pi for Better Performance

YOU'LL NEED THIS

RASPBERRY PI
These tips apply to any model.

HAS YOUR RASPBERRY PI SLOWED DOWN? It's a common problem—it doesn't matter which version of the Pi you're using, performance always suffers if the operating system isn't correctly configured. Using a lightweight operating system such as Raspbian Lite, DietPi, or piCore can help, but there's much more you can do. Performance boosts can be gained from overclocking, changing how RAM is used, and ditching bloatware, among other things. –CHRISTIAN CAWLEY

A



1 POWER RANGERS

The wrong power supply can wreak havoc with the performance of your Raspberry Pi [Image A]. With insufficient power to deal with processing requirements, bottlenecks can occur, slowing the computer right down. Low power can also result in read/write issues, which in turn can damage the microSD card (more on that later). Then there's the usual end result of a frozen Raspberry Pi: pulling the power lead and rebooting.

›› To avoid this, you need to give the Raspberry Pi a reliable power supply. This means using a good-quality PSU (if not the official device), rather than a spare USB port on your PC, TV, or power bar.

›› The official Raspberry Pi power adapter has a 100–240V input, and a 5.1V 2.5A output. If you're not using the official PSU, ensure that your supply matches this, and that the micro-USB cable is of good quality, in working order, and fits the Raspberry Pi correctly.

2 SUPER-SIZE PI

Using Raspbian Lite or some other lightweight distro is a good option for a stripped-back experience, but if you're looking for a more feature-packed operating system, the standard Raspbian installation is your best option.

›› A full gigabyte of storage space can be freed up by removing unused tools such as LibreOffice, the Wolfram Engine, Minecraft, and Sonic Pi. To benefit from this fully, however, you need to have the full capacity of the SD card. This means using the "Expand Filesystem" option in the raspi-config tool, or the "Raspberry Pi Configuration" menu on the desktop. You'll find this on the "System" tab.

›› Removing what might be unfairly termed "bloatware" on Raspbian is easy. Open a terminal prompt and type:

```
sudo apt purge libreoffice*
sudo apt clean
sudo apt autoremove
```

›› This removes LibreOffice from Raspbian. Replace the `libreoffice*` command with `wolfram-engine`, `minecraft-pi`, and `sonic-pi` to remove those tools.

›› With these four options removed, you'll have the advantage of increased storage space on your Pi without having the limitations of a lite distro.

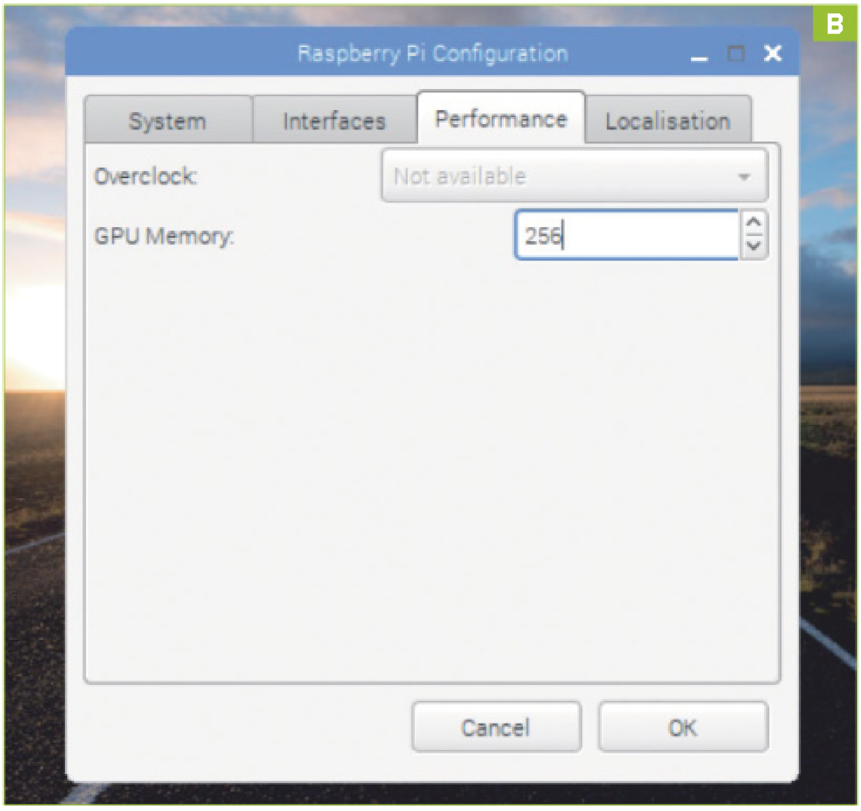
3 KILL JAVASCRIPT DEAD

While it's wise to limit the number of tabs you have open in your preferred web browser, further performance boosts can be gained by disabling JavaScript. How you do this varies according to browser. In Chromium, use "Menu → Settings → Advanced → Privacy and security → Content settings → JavaScript." Here, you need to switch "Allowed" to "Blocked."

›› Disabling JavaScript can improve your overall performance, as well as speed up any pages that rely on it. While this might mean that pages become less functional, it will also help to reduce the load on your Raspberry Pi from advertisements and trackers. Note that exceptions can be added to your browser settings to allow JavaScript to run on specific sites.

4 OVERCOME WITH AN OVERCLOCK

Massive performance boosts can be enjoyed by your Raspberry Pi by overclocking the processor. Raspbian offers this as a built-in feature that can be found in the raspi-config tool (other distros may require additional software). Access the overclocking tool by selecting "Overclock" on the main raspi-config menu. Depending on your Raspberry Pi model, you'll have several



Overclock: Not available

GPU Memory: 256

options here. The default option is "None," with the clock running at the basic 700MHz, but you could ramp things up to 1,000MHz and above with Turbo mode.

» Using the overclocking menu means you can avoid having to worry too much about stress testing, as the values on offer have already been tested. However, Turbo mode might cause problems, so it's a good idea to use a cooling solution.

» With a Raspberry Pi 3 and above, you can also edit the config.txt file in nano to specify values for the four overclock settings: "arm_freq," "core_freq," "sdram_freq," and "over_voltage." The usual overclocking rules of taking a baseline reading and increasing incrementally apply.

» The benefits of overclocking your Raspberry Pi include increased performance for video decoding in Kodi, or playing more games from the fifth- and sixth-generation consoles that can currently be emulated on the Pi. Emulation of Windows apps with the ExaGear software is also improved.

5

DITCH THE CHEAPO SD CARD

Finding the right microSD card for your Raspberry Pi can be tricky, but with the right capacity and speed, it can make a huge difference to how your Pi runs.

» The secret here is to stick to named brands, such as SanDisk, Samsung, and Kingston, while keeping an eye on the card's speed and rating. A higher rating indicates better speed and error connection, which will improve your Pi's performance.

» Once you've added a quality SD card, it's time to start looking after it. By now, you should know how to correctly shut down a Raspberry Pi. Doing so prolongs the lifespan of the SD card, saving you further outlay (however inexpensive a replacement might be), and the fuss of setting up your Pi again from scratch.

» From the desktop environment, be sure to shut down from the main menu. If you're using a Kodi media center distribution or a retro gaming suite, take the time to find the appropriate shutdown option, and use it.

» If it's quicker, or you're connected to your Pi over SSH, it's easier to shut down from the shell:

```
sudo shutdown -h now
```

» You can also schedule a time to shut down the Pi:

```
sudo shutdown -h 02:46
```

» An orderly shutdown ensures your SD card's integrity is maintained, as well as avoiding data loss.

6

ZIPPY ZRAM

RAM configuration options for the Raspberry Pi mean that you can easily designate a portion of RAM to the GPU if necessary, or reserve it for non-graphics tasks [**Image B**].

» Using the "Advanced Options" sub-menu in raspi-config, find the "Memory Split" option, and use it to specify how much memory the GPU should have. For example, if you're not using a desktop environment, you can set this to 16MB, allowing the Raspberry Pi's processor to benefit from extra memory. For graphics-intensive tasks, however, your GPU needs more of the RAM. Note that even with a Raspberry Pi 3 B+ (which has 1GB of RAM), you can't assign more than 256MB to the GPU.

» Perhaps the best performance tweak for the Raspberry Pi can be made to the RAM, utilizing unused space for swap data.

» As explained by YouTuber NovaSpirit Tech, ZRAM can be used as a swap disk. While the data won't persist following a reboot, this can speed your Raspberry Pi up considerably.

» Begin by grabbing the script from GitHub:

```
sudo wget -O /usr/bin/zram.sh https://raw.githubusercontent.com/novaspirit/rpi_zram/master/zram.sh
```

» Next, make the file executable, and edit "rc.local" to run the script when you reboot:

```
sudo chmod +x /usr/bin/zram.sh
sudo nano /etc/rc.local
```

» Look for the exit 0 line, and above it add:

```
/usr/bin/zram.sh &
```

» Hit Ctrl-X to save and exit the file. ZRAM swapping is far faster than relying on even the fastest microSD card, with an instant performance boost. ⏻

DON'T PUSH YOUR PI

As versatile as the Raspberry Pi is, it's a good idea to be certain that it's the right device for the project you have in mind.

You might just be using the Raspberry Pi for retro gaming or Kodi. It might be acting as a desktop replacement, or as the main component of an IoT project. If your Raspberry Pi is up to the task, it should work fine. The problem is when you choose a task that the Pi simply can't do, even when the hardware appears to be a good fit.

Conversely, the Raspberry Pi might be far too advanced for the task you have in mind, such as flashing an LED over the web, or something equally low-spec.

Perhaps there isn't quite enough RAM; or maybe the issue is with the ARM architecture. Whatever the problem, all the configuration tweaks and tricks in the world won't help if the hardware can't handle the project.

Even the Raspberry Pi 3 B+ isn't powerful enough for some situations. So, what's the alternative? Well, you could look at some of the Pi's nearest rivals, such as the Asus Tinker Board, Pine64, or even Odroid-XU4. Rather than trying to do everything with the Raspberry Pi, choose the right device for the job.

Create a Sign for a Dive Bar

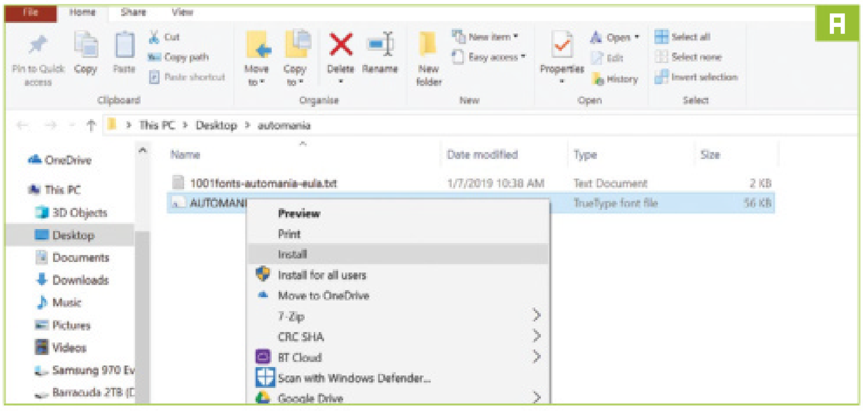
YOU'LL NEED THIS

PHOTOSHOP CC 2019
Subscribe to Photoshop at www.adobe.com.

TASTE FORGOT MANY DECADES, but exactly which ones depends on which era the beholder's eyes came of age in. The '90s, for example, can do nothing wrong, but the '70s were a mess of brown flares and poor automotive choices, and we don't understand the young people at all.

The '80s, however, will forever be associated with the neon lights of *GTA: Vice City* and some rad Saturday morning cartoons. It's a look that's begging to be recreated, and we have the technology in the form of Photoshop. We can make text glow as though made of lighting tubes, throw shadows behind it, and even make it blink on and off, as if in the window of a dive bar. Not that we'd know anything about those. We're also going to use one of the new features in Photoshop CC 2019, the Curvature Pen tool.

If we're being really picky about this, neon lighting—that is, lighting that uses the gas neon to produce its light—should be orange. Other colors come from other elements, so hydrogen gives red, mercury blue, helium yellow, and so on. This is 2019, however, and with Photoshop, we can have any color we want. Just don't expect restrained good taste. **–IAN EVENDEN**



1 GET A FONT

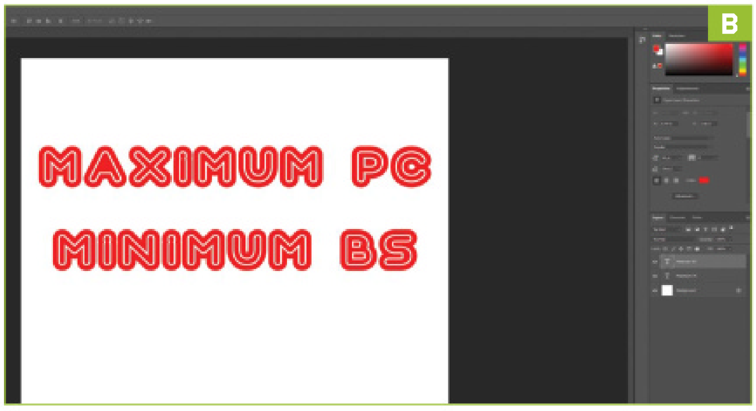
There are many places on the Internet you can obtain a font suitable for lighting up the window of your club; using the search engine of your choice and the words "neon font" returns many. Make sure, of course, that they are freely available for your chosen purpose before downloading—especially if it's commercial use you have in mind. Otherwise pay up. Installing a font in Windows 10 is simplicity itself—unzip the file on to your desktop or any other convenient folder, then right-click the font file, and choose "Install" from the menu [**Image A**]. Restart any apps you want to use the font in, and it should now appear in the app. The one we're using is Automania by Fenotype.

2 TRY IT OUT

Open Photoshop, create a new document, and try your new font out [**Image B**]. As you can see, we've gone for maximum tastefulness here. It's going to be perfect. If you're composing on a light background, this is a good time to make it darker—fill it with black or put a dark image behind your text—this makes it easier to see what's going on. Make your text a suitable color, then right-click its layer in the Layers palette, and choose "Blending Options." The window that pops up does indeed contain blending options, but also the Layer Styles for the layer, one of which is Outer Glow.

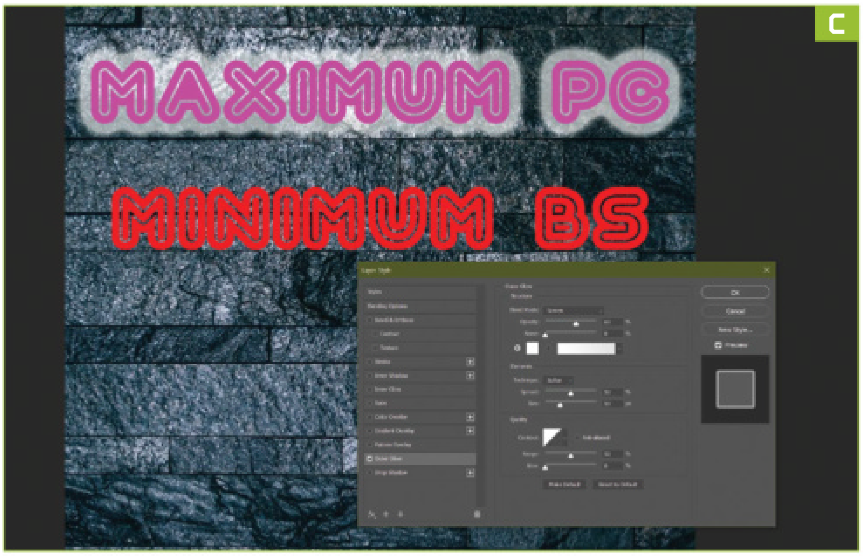
3 OUTER GLOW

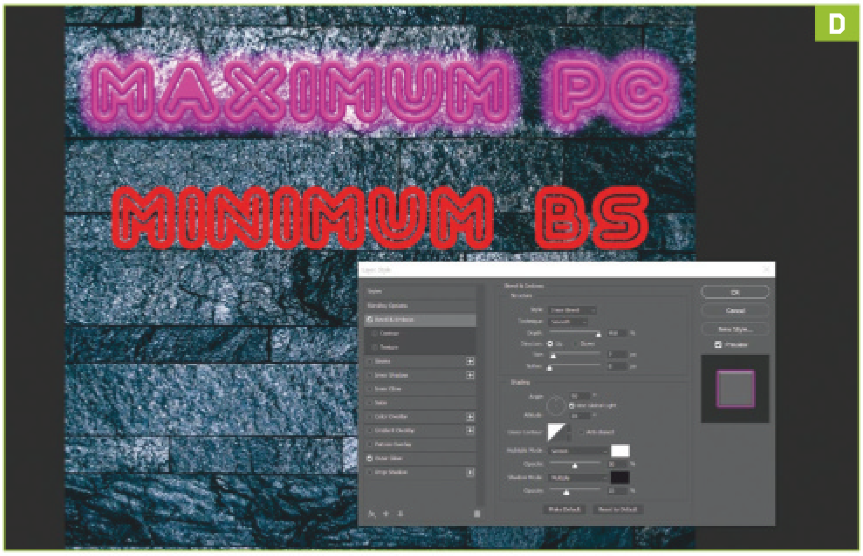
No "Gorgeous Ladies of Wrestling" here—maybe next month—but instead a soft glow emanating from your text. Mess around with the Outer Glow settings, particularly "Spread," "Size," "Range," and "Opacity," and change the glow's color from the default white to something more in keeping with your text color [**Image C**].



4 BEVEL

Still on the Layer Styles window, put a check in the "Bevel and Emboss" box, too. This adds a 3D look to your text, and creates the effect of the cylindrical tubing used to create flashing neon signs. With "Inner Bevel" selected, use the "Size" slider to create the illusion of depth, and the "Soften" control to spread the effect, removing any impression that your letters are coming to a point [**Image D**].





5

INNER SHADOW

Still on the Layer Styles window, try a little Inner Shadow to add definition to your letters, in case they're beginning to disappear into the glow. The "Choke" slider increases the darkness of your shadow, while the "Size" and "Distance" controls must be used with care, as they can move the shadow into the wrong position—we want it sharply around the letters. It's better not to have this effect than to have it spilling out into areas it shouldn't be in. A Drop Shadow makes the text appear to float above the background, but again be careful with where it falls. When you're happy with the effects, hit "OK." Layer Styles remain editable, so to change them later, just reopen the window.

6

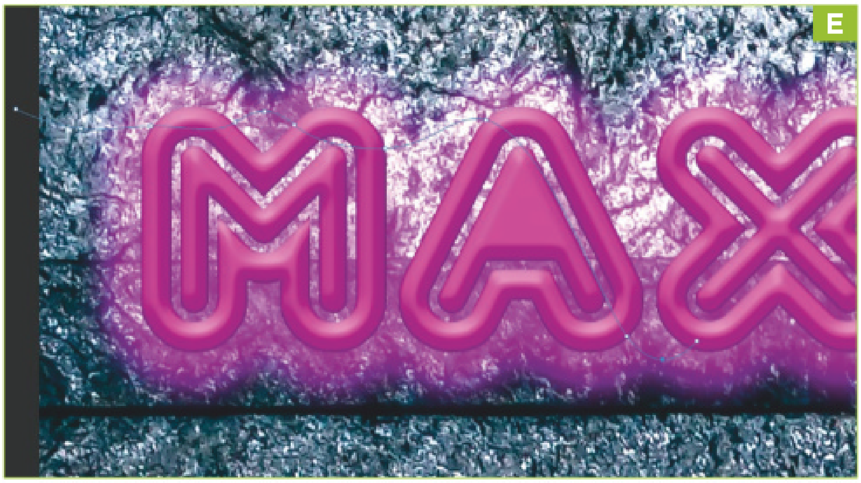
CREATE A CORD

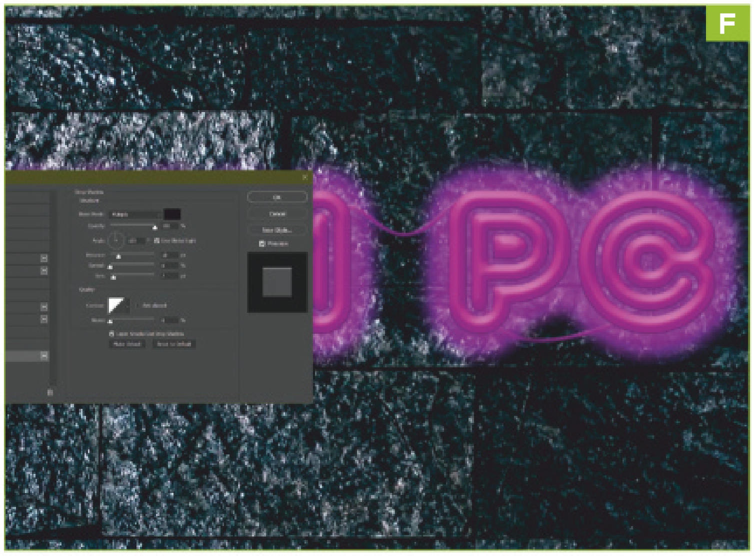
All this gas, stimulated into glowing by an electrical current, needs a power supply, so let's supply one. Create a new layer using the button at the bottom of the Layers palette or "Layer → New → Layer," then drag it in the layers stack so it's behind the text layer you've been working on—the cords would be behind the letters in a real sign. Select the Pen tool, which allows you to draw vector lines on your image, and a new feature in Photoshop CC is the Curvature Pen, found nested in the Pen tool on the toolbar. This makes it easier to create smoothly curved lines that emulate the way a real power cord would hang. Making sure you're on the new layer you created, click to create points, and the path is filled in between them. Click the path to create a new point, and drag it to modify the curve. The path appears as a thin blue line by default [**Image E**], but we can change that later.

7

STROKE

Stroking a path means running color along it, as if it were the path of a pen tip. Stroking uses the foreground color and the settings from your Brush tool, so choose "Brush," and select a small head. Change the foreground color to something like a darker version of the glow color. Open the Paths palette, select the path you made ("Work Path," probably), and use "Stroke" at the bottom of the palette to color it.

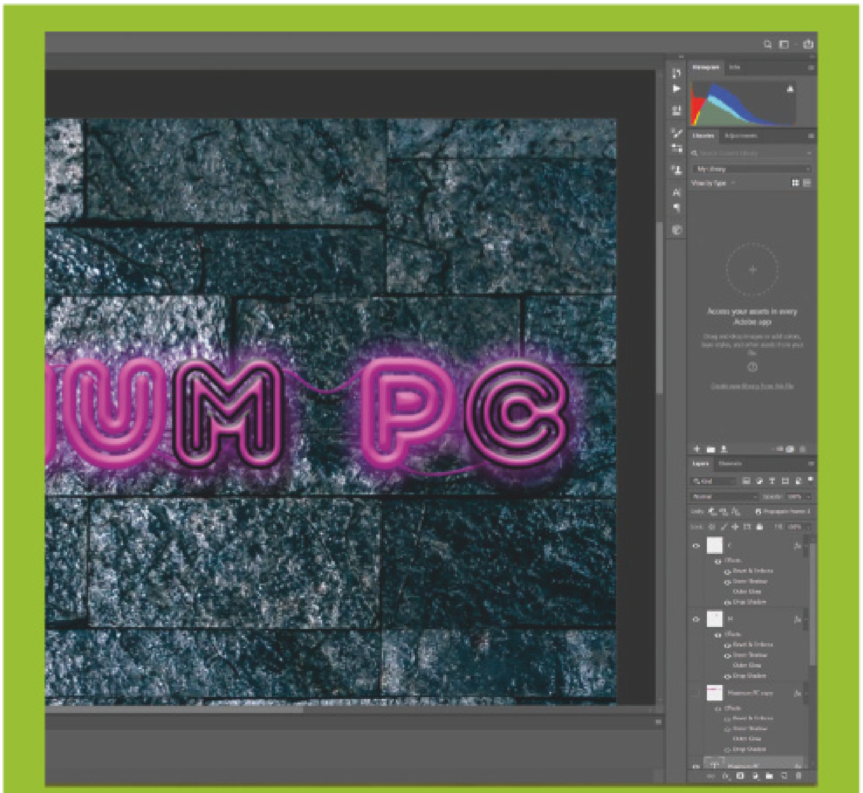




8

MORE LAYER STYLES

To give it a 3D effect, we can return to Layer Styles. Right-click the path's layer and hit "Blending Options" to open Layer Styles, then apply a little Bevel and Emboss, plus a bit of a Drop Shadow, to make it look 3D [**Image F**]. Save your work as a PSD file to preserve the layers so you can work on them later, and export as a JPEG or PNG to share or post online.



GET FLICKERING

Neon signs are notorious for flickering on and off, and you can create this effect by duplicating the text layer and removing the glow Layer Style. Increase the shadow and drop the opacity to make it look dull, too, and you have an "off" version of your lights. Use the Rectangular Marquee to chop the text up (you need to rasterize the type layer first, so make sure you're happy with your layer effects), with "off" versions of individual letters on their own layers. Then move to Photoshop's Motion workspace and create frames in which these "off" layers overlay the original lit ones. You can then export this as an animated GIF, with letters flickering on and off as much as you like.

BUILD IT

ZAK STOREY, CONTRIBUTING EDITOR

A Build for a Buddy

A $1,500 budget, and a kick-ass gaming PC upgrade for a friend in need

LENGTH OF TIME: **1-2 HOURS**

LEVEL OF DIFFICULTY: **EASY**

THE CONCEPT

A BUDDY of ours approached us at the end of last year with a question. His rig was getting dated, his Core i5-4690K quad-core processor wasn't as punchy as he'd like, and although he had a fairly solid GPU (a GTX 1070), he wanted to know what we'd recommend he do with a $1,500 budget. Cue a quick trip to PCPartPicker, and a few select questions.

The first thing we always ask people who throw that particular query at us is: "What are you interested in doing with your rig?" It's a very open-ended question, but it makes a lot of sense to ask, because there's no perfect solution that'll answer every problem in the world of computing. Sure, a $25,000 hyper-rig might be able to game well, compute advanced neural nets, or simulate your fantasy football league with ease, but if you only want to play *World of Warcraft* at 1440p, spending your money on a 28-core Xeon processor and 2.5TB of ECC memory is not going to be a good investment, no matter how you spin it.

Our friend's answer was fairly simple: *WoW* at 1440p, and AAA gaming on the side. He's already got the screen setup, plus the GPU, so all that was left for us to do was work on the infrastructure—the storage, processor, motherboard, cooling, and, more importantly, the case—and give the whole thing enough gumption to last four to five years, without feeling sluggish once more.

ASUS
SAMSUNG
NZXT

PARTS GALORE

SO, WHERE DO WE BEGIN with that budget? First things first: processor and motherboard. Because this guy's mantra is gaming, we've gone with an Intel Core i7-8700K. We chose it for a number of reasons. The big clock speeds and single-core performance should help quite dramatically in game—six cores and 12 threads are plenty for what he has in mind—and despite the fact that it doesn't have a soldered IHS, temperatures are roughly the same as its eight-cored 9900K sibling. It's also much cheaper than the latter part, which is good news for us, because it's more important that we spend that cash elsewhere.

Speaking of which, the motherboard we've picked is the latest Z390-i ROG Strix Gaming from Asus. This little ITX juggernaut is packed with all the staple ITX features we've come to love from the Taiwanese company, with impeccable audio, integrated M.2 heatsinks, and a whole splurging of I/O on the rear.

Memory-wise, we originally bought a kit of 32GB (2x 16GB) Corsair Vengeance LED DDR4 @ 3,200MT/s, which, although more than adequate for this rig, unfortunately conflicted with our liquid cooler, because it was too tall. So, we swapped it out for the G.Skill Trident Z kit we already had in stock (included in the "Ingredients" list on the right).

On top of all that, we're packing the whole lot inside an NZXT H200i small form factor chassis, along with a Kraken X52 240mm AIO, and an M.2 PCIe SSD.

INGREDIENTS

PART		STREET PRICE
Case	NZXT H200i	$130
Motherboard	Asus ROG Strix Z390-I Gaming Mini-ITX	$199
CPU	Intel Core i7-8700K	$350
CPU Cooler	NZXT Kraken X52 240mm AIO	$132
GPU	Asus GeForce GTX 1070 Dual	$450
Memory	32GB (2x 16GB) G.Skill Trident Z @ 3,200MT/s	$260
PSU	Corsair RM850i 80+ Gold	$160
Storage 1	500GB Samsung 970 Evo M.2 PCIe SSD	$128
Storage 2	1TB Samsung 860 Evo 2.5-inch SSD	$147
OS	Windows 10 Home 64-bit	$100
Total		$2,056

1

H200i SUPERIORITY

AS USUAL, WE BEGAN THE BUILD with a case strip-down. We'll be repeating this until we're blue in the face, but it's so much easier to build a system in a case that has as many of its panels removed as possible. Of course, if you get the opportunity (especially in an ITX build), you should always test your hardware outside of the chassis first, before installing it, because it's easier to return and RMA parts when they've been assembled on top of a mobo box (all of them are antistatic) than install it all, try to get it to work, then have to pull it all back out, at which point you need to send it back to your eseller of choice. Unlike the H400i variant of NZXT's lineup, the H200i comes with a removable front panel, too, making it easier to install 240mm AIOs in there.

2

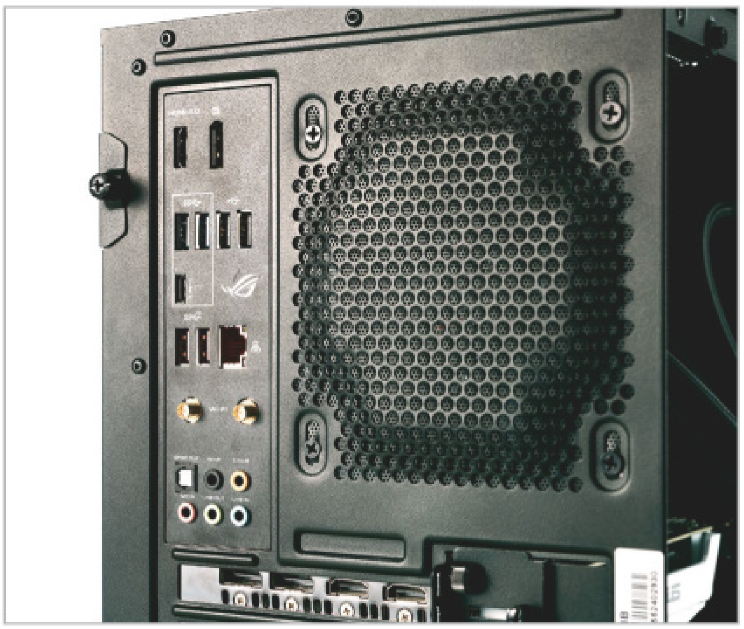
USB 2.0 CONUNDRUM

WHO'D HAVE THOUGHT we'd reach this point? Yup—not enough internal USB 2.0 headers on the motherboard to satisfy our needs. We require two of them, but the Z390-I only supports one. Why two? One for the NZXT H200i's integrated fan and lighting controller, and another to power and control the infinity mirror baked into the NZXT Kraken X52. It's a little frustrating that we can't complete this setup right now, so we've taken the liberty of pre-installing the CPU USB cable, ready for when our additional USB 2.0 internal hub turns up.

3

REAR I/O PLATE

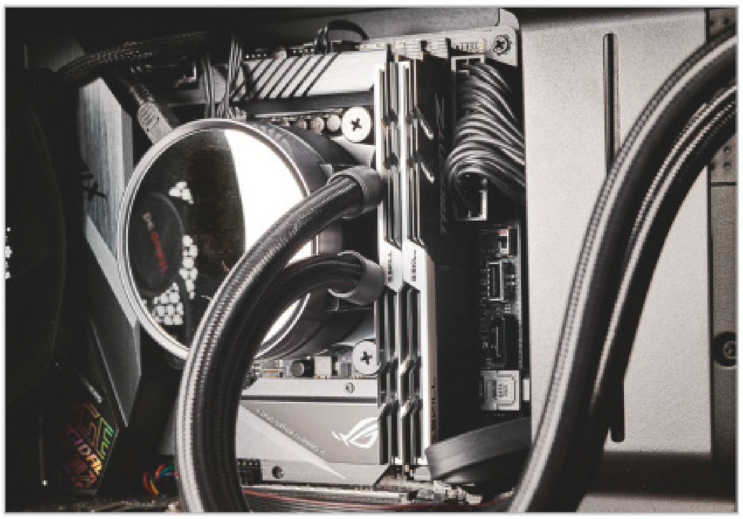
IT MIGHT NOT have enough internal USB 2.0 headers, and that's a bit of a shoddy front panel header (more on that later), but that's not to say the Asus Z390-I ROG Strix Gaming isn't a good mobo. One thing we're particularly fond of is the inclusion of a pre-mounted rear I/O shield. No more building half your rig, forgetting it's there, sitting at the bottom of the box. We're also in love with the included M.2 heat spreader, which should help dissipate the heat when our friend is hammering in those sequential transfers on his Samsung 970 Evo 500GB.



4

MEMORY MISHAPS

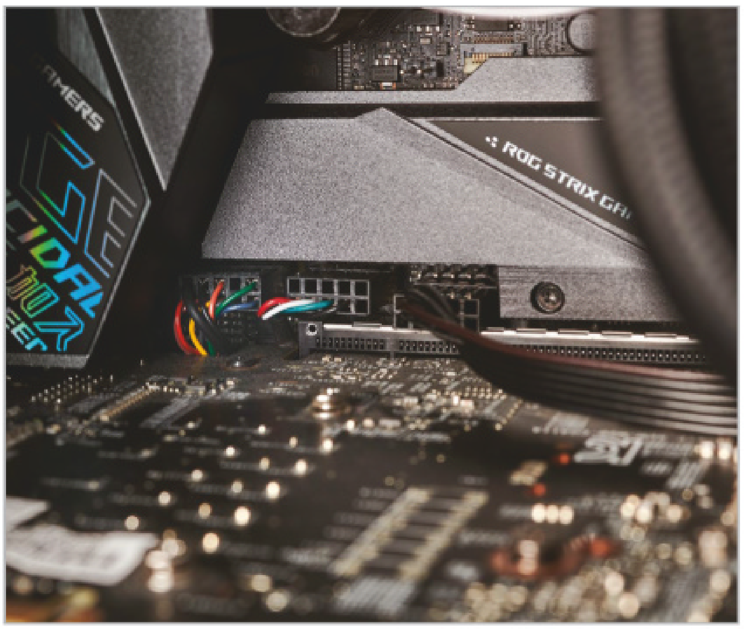
WE FIRST SPECCED OUT THIS BUILD to use Corsair's Vengeance Pro RGB memory. With white LEDs, these things would have looked baller shining away on the interior of this setup. Alas, the best-laid schemes of mice and men, and all that—we just couldn't get them to fit with the cooler without conflicting with the inlet and outlet ports for the tubing runs to the radiator. There was a solution—rotate the CPU block, so both ports were facing upward—but our OCD was screaming about the misalignment of the NZXT logo (yep, we're that petty). So, we swapped the Vengeance Pros out for a sweet G.Skill Trident Z kit instead, which fits just fine here, and doesn't cause any conflict.



5

FRONT HEADER HELL

THIS IS JUST DUMB. What you're looking at in the shot below is the location of the front headers. That's right, sitting directly above the GPU—right in the middle, not at one end or the other—is the front panel header for your on and off switch. Seriously, Asus? This is a premium top-end motherboard, developed for premium-looking systems, and you place the I/O header there? We had little choice but to run the cable along the top of the GPU, and then just hook it out of the way—but, man, talk about frustrating....

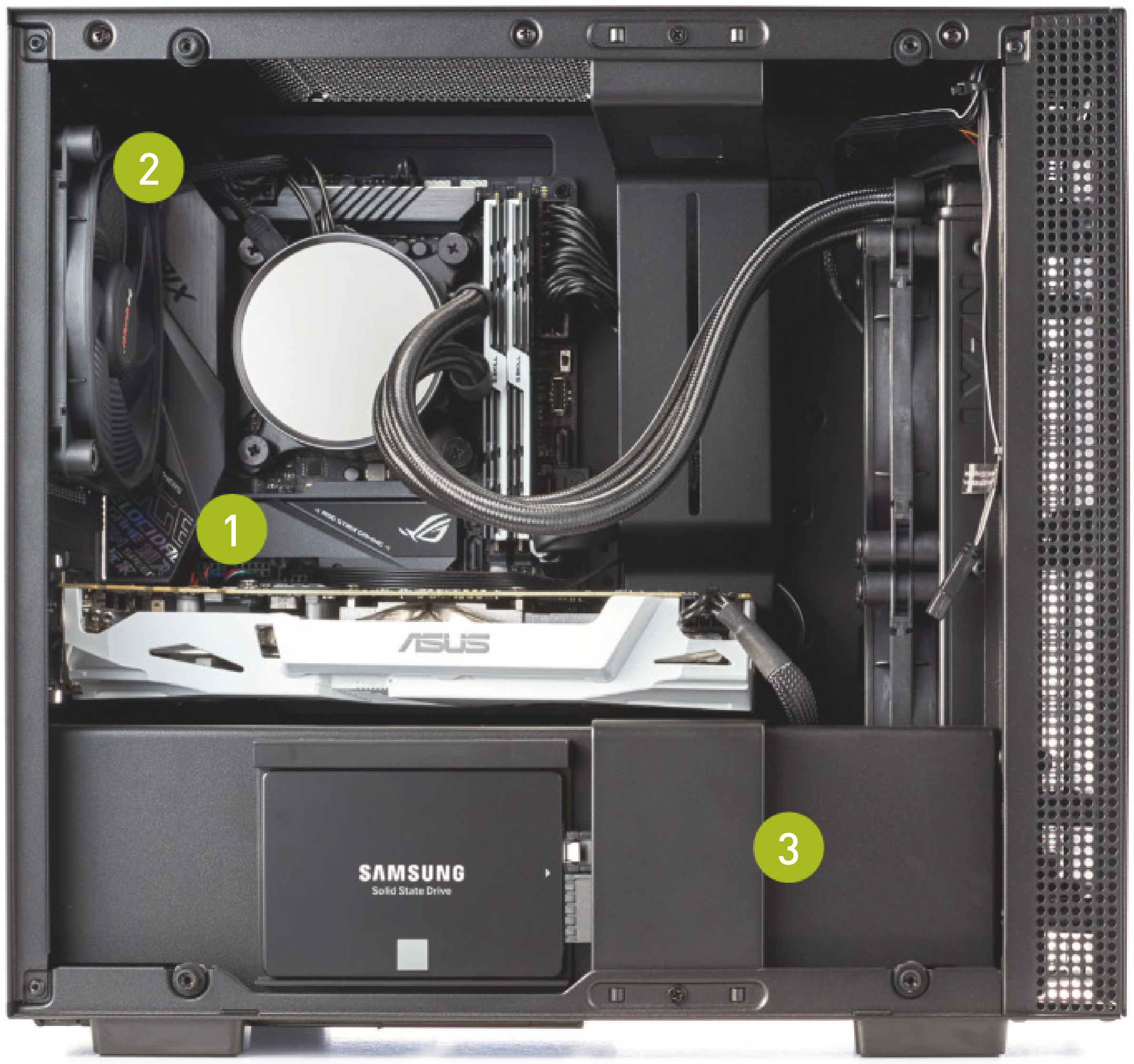


6

SMART FANS?

IT'S NOT AS SMART as we'd like, but the fan controller in the back has been developed to analyze the noise in the chassis and adjust the fan curves for it. Unfortunately, it's a bit sluggish, and takes a ridiculously long time to set up those custom fan curves based on noise. In fact, we recommend you go into the CAM software and set up your own instead. It also supports the integrated LED lighting strip in the top of the chassis, and you can add another (available separately) if you fancy more RGB fun. It supports a bucketload of fans, too, which is nice, as we don't need to plug any into our motherboard. We do recommend plugging your pump into the CPU fan header, though, to stop the Asus mobo protection freaking out, and preventing you from booting.

LED
USB
POWER
FAN 3
FAN 2
FAN 1
H200i



1 **World of Headercraft is what we should call this build. Seriously, why is this front header here?**

2 **Cooling is supported by a few Be Quiet! Silent Wing 3s that we had lying around—they're some of our favorite fans.**

3 **Although not pictured, we have an NZXT internal USB hub on the way to help alleviate our AIO lighting woes.**

WORK TO DO?

THERE YOU HAVE IT: a fairly clean upgraded system. You might be asking what we kept from the old rig, and that would be a fair question. It was the GPU, and only the GPU. As a GTX 1070 Dual is still a fairly recent card (and new GPUs are ridiculously expensive), it made sense to hold on to it for now, rather than waste the budget. It's a good card, and as our friend predominantly only plays *WoW* at 1440p, it'll be more than enough to keep him going for at least another two years.

That said, ironically, it's probably one of the few things we would change about this system. Getting that out and replacing it with something like an EVGA Black 2080 XC would make the most sense, both aesthetically and for the future life of the system.

All in all, though, we didn't have any major problems when it came to building this system. The only tricky bit was routing those front panel headers on top of the GPU. We also plugged in the HD audio pass-through to the left of it, which means carefully and expertly installing your GPU after you've done that, making sure you don't pinch the cable too badly in-between, but that's an inevitability with a lot of small form factor systems. If this were a build for one of our team, the likelihood is we'd have not installed it at all—after all, pass-throughs are notoriously dirty when it comes to quality audio, and it's not exactly too difficult to install your audio cables to the rear I/O of a machine like this, especially when it'll plop on to most desks with ease.

Performance-wise, the numbers are good, and where we'd expect them to be. Cinebench R15 multicore clocks in at a sweet 1,522, with single-core just nudging the 200 bracket at 197. CrystalDisk read and writes were equally as high, and gaming performance was also fairly well rounded.

What would we change if this were our build? Not a lot. Perhaps different memory. Liquid-cooling this rig, although tempting, isn't particularly viable. The NZXT H200i certainly ain't no Manta, and running a single 240mm rad, regardless of how thick it is, wouldn't be enough to satisfy the cooling of both a GPU and a CPU in a setup like this, especially with a full-length card. It's not impossible, of course, but you have to question whether it would be worth it. The biggest change we could make is to delid that CPU, and drop some liquid metal in it, or at least some better quality thermal paste. A temperature drop here of 10–15 C would make a world of difference, especially in the warmer months. ⏻

BENCHMARKS

	ZERO-POINT	
Cinebench R15 Multi (Index)	1,152	1,456 (26%)
CrystalDisk QD32 Sequential Read (MB/s)	3,400	3,422 (1%)
CrystalDisk QD32 Sequential Write (MB/s)	1,720	2,324 (35%)
Rise of the Tomb Raider (fps)	37	55 (49%)
Total War: Warhammer II (fps)	46	71 (54%)
Tom Clancy's Ghost Recon Wildlands (fps)	39	56 (44%)
3DMark: Fire Strike (Index)	11,101	16,012 (44%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Our zero-point consists of an AMD Ryzen 5 1600, 16GB of Crucial Ballistix Sport LT @ 2,666MT/s, an EVGA GeForce GTX 1060 3GB, and a 250GB Samsung 960 Evo M.2 PCIe SSD. All tests were performed at 1080p at the highest graphical profile.

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Falcon Northwest Mach V

Daring to dream, with a rig of top-tier components

YOU MIGHT HAVE noticed that we didn't have a Dream Machine in 2018. The realities of that monstrosity of work are harsh, and trying to get new parts that clearly outperformed 2017's model wasn't going to happen. As an alternative, allow us to present Falcon Northwest's Mach V. If we were to spec out a Dream Machine for 2019 right now, the components would look uncannily similar to this.

Let's start at the top, with the pair of Nvidia's beastly Titan RTX cards, running in tandem with an NVLink bridge. Each has a whopping 24GB of GDDR5, and together it's one-third of the price, if you're keeping score. Outside of professional GPUs like the Quadro, there's nothing faster. The same goes for Intel's Core i9-9980XE, which Falcon overclocked to 4.2–4.9GHz, depending on how many cores are in use. A good liquid cooler is required, as CPU-intensive tasks can cause system power draw to peak at more than 650W, 400W of which comes from the overclocked processor. And if you load up the GPUs as well, you can hit 900–950W at the outlet.

The rest of the specs are similarly impressive, with top-of-the-line memory, motherboard, storage, and power. Wrap it all up in a very large custom chassis designed by Falcon Northwest, and you're ready to rock. For good measure, add an Exotix paint job, a $1,100 add-on that can be customized further if you see fit. Rigs like this are truly a sight to behold.

If you're looking at the spec list and thinking you could build a similar system for less, you're absolutely right. But the fact is, you wouldn't save that much money (about $2,000), and anyone considering this level of hardware supremacy is probably part of the "time is money" crowd. Having a reputable vendor like Falcon Northwest put it all together, including an extensive 48-hour burn-in test suite, with system overclocking if you're interested, plus a three-year warranty (and free overnight shipping provided during the first year), and there's actually a value proposition of sorts on offer.

MONEY MATTERS

All of that naturally depends on your being able to put the hardware to good use. This is absolutely workstation-class hardware, with components and features that can give Nvidia's DGX Station a run for its money. Yes, it has two fewer GPUs than the DGX Station, but let's be clear: You can buy three of these Mach V systems for the price of a single DGX Station—and still have several thousand dollars to spare. And while you won't get the Tesla V100 32GB cards found in Nvidia's workstation, you'll get the enhanced ray-tracing features and gaming performance of the newer Turing RTX cards.

That's precisely the sort of use case that's popular with Falcon's customers. While the Mach V is absolutely capable of playing games—just look at the benchmarks, where even 4K ultra plugs along at frame rates well in excess of 60, often more than double the performance of our zero-point 1080 Ti rig—it's really the content creators and AI researchers looking for high-performance alternatives to Nvidia's DGX Station who will find plenty to love with the Mach V. And you can always customize any aspect of the build, with the base models starting at a far more palatable $3,100, albeit with less impressive specs.

You don't need rig like this for pure gaming purposes, or plenty of other tasks, to be honest. It's complete overkill, and an increasingly large number of games don't even have working multi-GPU support, so one of the Titan RTX cards often sits idle. But if you're into cutting-edge research or you want to work on creating ray-traced games? The only way you're going to significantly improve on the Mach V is to wait for the next round of GPU and CPU updates, which could be a year or more away. Now, we just need to figure out how to top it with our own Dream Machine. **–JARRED WALTON**

VERDICT
9
KICK ASS!

Falcon Northwest Mach V

➕ **DREAMY** Beautiful build; insanely powerful; a cheaper DGX Station.

➖ **NIGHTMARE** SLI support lacking from games; guzzles power; diminishing returns.

$15,505, www.falcon-nw.com

BENCHMARKS

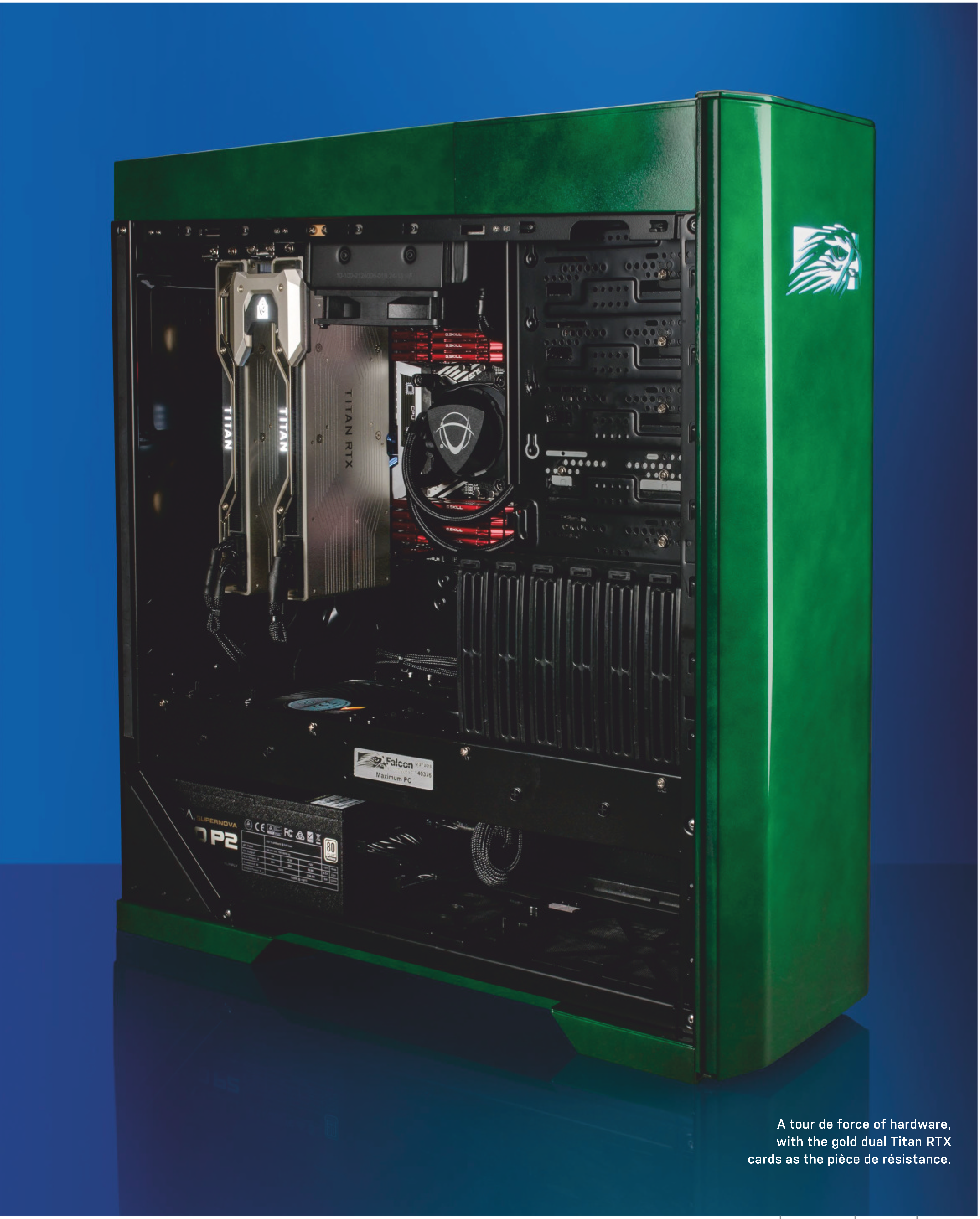
	ZERO-POINT	
Cinebench R15 (Index)	2,178	4,099 (88%)
CrystalDisk QD32 Sequential Read (MB/s)	3,136	3,260 (4%)
CrystalDisk QD32 Sequential Write (MB/s)	2,126	3,161 (49%)
3DMark: Fire Strike (Index)	6,988	16,847 (141%)
Rise of the Tomb Raider (fps)	68	150 (121%)
Total War: Warhammer II (fps)	42	99 (136%)
Tom Clancy's Ghost Recon: Wildlands (fps)	38	73 (92%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Our zero-point consists of an an Intel Core i9-7900X, 32GB G.Skill RipJaws V series DDR4 @ 3,000, an MSI GeForce GTX 1080 Ti Gaming X, and a 512GB Samsung 960 Pro PCIe SSD. All tests performed at 4K at the highest graphical profile.

SPECIFICATIONS

CPU	Intel Core i9-9980XE
Motherboard	Asus X299 Prime Deluxe
Graphics	2x Titan RTX 24GB
Cooling	Asetek 650LX
Memory	8x 16GB G.Skill DDR4-3000
OS Drive	2x Samsung 970 Evo 2TB RAID 0
Data Drive	Samsung 860 Evo 4TB
Power Supply	EVGA SuperNOVA 1200 P2
Case	Mach V
Warranty	Three years; one year overnight shipping


TITAN
TITAN
TITAN RTX
Falcon
Maximum PC
SUPERNOVA
P2

A tour de force of hardware,
with the gold dual Titan RTX
cards as the pièce de résistance.

Origin PC Neuron

A cornucopia of cool customization options

BUILDING A GAMING PC yourself means being able to customize it specifically for the games you want to play, whether you're a casual player or a full-time streamer. But if you can't build your own, where do you turn to get something completely custom? Origin's all-new customizable Neuron is yet another option for gamers and streamers who don't want to fuss with the consuming aspects of piecing a rig together.

The Neuron comes in many different configurations, including a CPU up to either an Intel Core i9-9900K or an AMD Ryzen 16-core Threadripper, and a GPU up to an Nvidia RTX 2080 Ti. The unit we were sent is a little different from the one in the photos; it's red, and sans RGB lighting, but it's got a great list of components that include an overclocked eight-core AMD Ryzen 7 2700X (4.3GHz Turbo Boost), and an overclocked 8GB RTX 2080 Founders Edition.

In terms of customization, Origin offers HD UV glass printing and laser etching. You can send Origin your favorite game art, and voila—the tempered glass now has an image that speaks to your gaming personality. The rounded edges on the front of the case look a little dated compared to the clean, sharp lines of other chassis on the market, but if case aesthetics are a long way down your must-have list, it's not a deal-breaker.

The microATX case is not only compact and lightweight, but it can also be oriented sideways and upside down, which could come in handy if you have a unique desk setup, and the feet are magnetic, so it's easy to change the orientation. The tempered glass side panel swings open on sturdy metals hinges, with two simple magnets to hold it closed. There's even a small groove at the edge of the panel, so you can open it without getting fingerprints on the glass.

Performance-wise, this Neuron build spits out the expected benchmark scores. Cinebench puts multicore performance at an average of 1,845, and 3DMark churns out scores of 20,850 (1080p), 12,650 (1440p), and 6,715 (4K). According to in-game benchmarks at 1080p on ultra, *Shadow of the Tomb Raider* sees an average of 109fps, while *Total War: Warhammer II* sees between 81fps and 100fps. *Ghost Recon: Wildlands* saw a lower frame rate, at 73fps, but it's a graphically intense game.

Our Neuron configuration came with an overclocked Ryzen 7 2700X, so it's no surprise there's an all-in-one liquid cooling system to go with it, but it's noisy. Most of the noise comes from the fans on the aforementioned cooler, and it seems as though that's how they sound naturally. Considering there are other quieter systems on the market with the same or similar specs, it's a sour point for an otherwise fine system.

During the benchmarking process, the system did run on the warm side, directly behind where the CPU was placed on the motherboard. Going back and playing *Shadow of the Tomb Raider* for a period of time made the case quite warm. According to HWMonitor, however, running *Tomb Raider* for less than ten minutes increased the CPU temperature to only 41 C—maybe that heat was just a weird, temporary quirk.

Origin offers a lifetime service agreement, which includes free upgrades and repairs to your system. It also offers a trade-in graphics card program to reduce the cost of the new GPU (although on the model we received, there is no included part upgrade service). It's these strides in customer support that can make one custom prebuilt service more enticing than another. Origin will also overclock your system for free, and offers 27/4 US-based support.

This unit will set you back $2,490, which is close to what it would cost to build a similar PC yourself. With so many custom prebuilt options to choose from, saving time and the headache of cable management—not to mention the extra-mile customer support—might be worth the extra cash. **–JOANNA NELIUS**

BENCHMARKS

	ZERO-POINT	
Cinebench R15 (Index)	1,152	1,845 (60%)
CrystalDisk QD32 Sequential Read (MB/s)	3,400	3,572 (5%)
CrystalDisk QD32 Sequential Write (MB/s)	1,720	2,342 (36%)
3DMark: Fire Strike (Index)	11,101	20,850 (88%)
Rise of the Tomb Raider (fps)	60	109 (82%)
Total War: Warhammer II (fps)	46	95 (107%)
Tom Clancy's Ghost Recon: Wildlands (fps)	39	73 (87%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Our desktop zero-point consists of an AMD Ryzen 5 1600, 16GB of Crucial Ballistix Sport LT @ 2,666, an EVGA GeForce GTX 1060 3GB, and a 250GB Samsung 960 Evo M.2 PCIe SSD. All tests were performed at 1080p at the highest graphical profile.

VERDICT

8

Origin PC Neuron

IMPULSE Magnetized tempered glass panel; compact case size; customer support options.

NERVY Noisy CPU cooler; case aesthetic.

$2,490, www.originpc.com

SPECIFICATIONS

Processor	AMD Ryzen 7 2700X 3.7GHz, 4.3GHz Turbo Boost (overclocked)
Graphics	GeForce RTX 2080 Founders Edition 8GB (overclocked)
RAM	16GB (2x 8GB) DDR4 powered by Kingston 3,000MHz
Motherboard	MSI B450M Bazooka
Primary Storage	512GB Samsung 970 Pro PCIe NVMe M.2 SSD
Additional Storage	Seagate 2TB SATA HDD
Cooling Solution	Origin Frostbyte 240 sealed liquid cooling system
PSU	750W EVGA SuperNOVA G3
Case	Origin Neuron
Warranty	Lifetime 24/7 US-based support and lifetime free labor; one-year part replacement; 45-day shipping warranty

GEFORCE RTX

Simple. Discrete.
Fully customizable

Razer's new 13-incher is a lovely physical object, but it isn't a gaming powerhouse.

Razer Blade Stealth 13

Slim, slick, and slightly gameable

THE HYPE SURROUNDING Apple and its premium-priced products is often completely out of control, but there's no point pretending Apple hasn't had a huge impact on the look and feel of laptop PCs. High-quality unibody laptop chassis machined out of solid aluminum are now the norm among premium portable PCs, and that is a direct consequence of the design of Apple's MacBook Pro models.

It's therefore no surprise to find that the industrial design of Razer's latest ultrabook PC closely mirrors the established Apple template. The precision-machined unibody of the new Razer Blade Stealth 13 not only adopts the same crisply beveled shape and hewn-from-billet physical feel as the MacBook Pro 13, but it's also within a fraction of a millimeter of the MacBook for width and thickness, and is just a few millimeters deeper too.

Do not, however, assume the new Stealth 13 is just another lazy MacBook clone. Razer has applied its own interpretation to the premium 13-inch portable category, starting with that signature all-black aesthetic. Notably, the Razer logo on the screen cover is not backlit, contributing to what is a more mature overall design vibe. Granted, its user-configurable, albeit single-zone, RGB backlit keyboard does retain some visual links to the gaming community, but the overall impression is slick and subtle. The Blade Stealth 13 would not look out of place in a professional context, that's for sure.

The other standout feature is the inclusion of Nvidia's GeForce MX150 graphics chip, in full-power 25W specification. What we have, then, is a quality 13-inch notebook with at least some gaming props. Other highlights include a powerful quad-core Intel Core i7-8565U processor, a super-quick 256GB NVMe M.2 drive, and 16GB of memory. For the record, the screen clocks in at 13.3 inches, runs its 1080p native resolution at 60Hz, and benefits from IPS technology.

GRID REFERENCE

Configured thus, it's the middle of three available models, with the flagship SKU upping the SSD ante to 512GB, and upgrading the screen to 4K with touch. Common to all Stealth 13s are the USB Type-C sockets on both sides of the chassis. The right-hand port is also Thunderbolt 3 compliant, which means four lanes of PCI Express connectivity, and support for external graphics boxes for serious, if expensive, gaming action. As for the battery, it's a 53.1Wh unit, and in this configuration is claimed to be good for up to 11 hours of grid-free operation.

Performance-wise, the vital question is whether this laptop can truly game. The answer isn't straightforward. Run something well optimized, like *Fortnite*, and you can set it to 1080p and medium quality, and get decent frame rates. For more demanding triple-A titles, our benchmarks demonstrate you'll either need to knock the image quality to low or reduce the resolution to 720p, and thus non-native and suboptimal for the 13.3-inch IPS panel. Even then, don't expect buttery smooth performance. All of which means the Stealth 13 can play games, but it will be up to you how rewarding it is.

Games aside, the 13-inch screen is a peach. Highlights include punchy colors, great viewing angles, strong contrast, and a nice matt anti-glare coating that strikes a good compromise between reduced reflectivity and avoiding annoying sparkle. As for battery life, we extracted a little over seven hours of video playback. For general use, you should see at least five or six hours; add an hour or two depending on your MO and how bright you run the screen. So, it's getting on for all day in some situations, even if the 11-hour claim is optimistic.

Further factor in the pleasingly solid and tactile keyboard, and you have a very compelling 13-inch proposition. Except, of course, for the fairly painful price. $1,599 for this mid-tier config is a bit much. So, this is a lovely laptop, it's just not conspicuous value. **–JEREMY LAIRD**

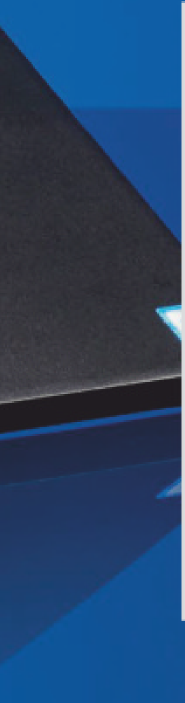
VERDICT
8

Razer Blade Stealth 13

+ STEALTHY Fantastic design and build quality; strong CPU performance.

− UNHEALTHY Battery life merely OK; gaming performance marginal.

$1,599, www.razer.com



BENCHMARKS

	ZERO-POINT	
Cinebench R15 Multi (Index)	743	698 (-6%)
CrystalDisk QD32 Sequential Read (MB/s)	563	2,900 (415%)
CrystalDisk QD32 Sequential Write (MB/s)	133	1,100 (727%)
3DMark: Fire Strike (Index)	13,202	3,292 (-75%)
Rise of the Tomb Raider (fps)	99	21 (-79%)
Total War: Warhammer II (fps)	62	12 (-81%)
Tom Clancy's Ghost Recon: Wildlands (fps)	48	18 (-63%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Our laptop zero-point is the Asus GL502VS-DS71, with an Intel Core i7-7700HQ, an 8GB GTX 1070, and 16GB of DDR4-2400. All game tests are performed at 1080p at the highest graphical profile.

SPECIFICATIONS

Processor	Intel Core i7-8565U quad-core
Graphics	Nvidia GeForce MX150 25W
RAM	16GB DDR4
Screen	13.3-inch 1080p 60Hz IPS
Storage	256GB NVMe M.2
Keyboard	Single-zone RGB
Battery	53.1Wh
Total Weight	1.3kg

Samsung 860 QVO 1TB

Cheaper, bigger; but at what cost?

BE CAREFUL WHAT YOU ASK FOR, you just might get it. That's essentially how it's shaken out with the new generation of QLC solid-state drives. QLC, of course, refers to the quad-level cells in the latest NAND flash memory, translating into four bits of data stored per cell, and thereby increasing storage density over existing TLC or triple-level cell NAND by a hefty and instant 33 percent.

What's not to like? With the Crucial BX500 and Adata SU630, quite a lot. The downsides to QLC memory are the same in character as every other increase in NAND memory cell data density to date. The problem is scope. When the original single-level memory cell was usurped by MLC cells, which store two bits per cell, both performance and endurance suffered. That happened again when TLC upped the ante to three bits per cell.

Here we are again with QLC memory, and thus far, the downsides have been even more painful. To put some really rough numbers on all this in terms of endurance, SLC memory is good for about 100,000 program-erase cycles. By the time you get to QLC NAND, you're looking at more like 1,000. As for performance, suffice to say that QLC involves 16 possible voltage levels per cell, and that in turn makes reading and writing data extremely laborious. This is the context for Samsung's new 860 QVO drive.

The 860 QVO is essentially a QLC-powered update to Samsung's existing 860 EVO 2.5-inch SATA drive. As you'd expect from a QLC product, it majors on capacity. It uses the same hardware platform as the EVO, including Samsung's MJX controller chip, and the same 1GB of LPDDR4 cache memory. But this 1TB model is the smallest 860 QVO on offer, alongside 2TB and 4TB alternatives.

ATTENTION TO DETAILS

The headline performance claims are very similar between the EVO and QVO, too. Until, that is, you look at the finer details. Samsung says the QVO is good for 520MB/s writes when operating a chunk of its QLC memory in faster SLC mode. It rates the underlying performance of the QLC memory at just 160MB/s for writes.

By default, the 1TB QVO has 6GB of memory partitioned off for high-speed SLC operation, with a further 32GB available for dynamic partitioning into SLC mode. In our testing, the steps in performance are obvious enough. When writing large sequential data sets internally on the QVO, transfer speeds start at around 500MB/s before quickly dropping to 250MB/s. That's the DDR4 cache filling up. After a further five or six GB, it drops to just 60MB/s. We couldn't see any evidence in that workload of the further 32GB of memory being dynamically allocated for SLC mode.

The upshot, as it has been with the other QLC drives we've tested, is that you're exposed to the underlying performance of that slow QLC memory pretty quickly. As for our official benchmark results, the sequential numbers reflect the drive's performance using the DDR4 cache, while the 4K random access performance is reasonable, if a little disappointing in terms of reads. In the QVO's favor, the 30GB internal file copy test shows that it does a better job of masking the inherently poor performance of the QLC memory than its direct competitors, but it's still far, far slower than the 860 EVO with its TLC memory.

The endurance hit takes the form of a three rather than five-year warranty, and write endurance rated at 360TB rather than the 600TB of the 1TB 860 EVO. To what extent all that is a deal-breaker is up to you. But what we can say is that the new QVO doesn't come at much of a discount. As we go to press, it's available for $138 on Newegg.com to the EVO's $148. In our view, that's not nearly enough of a price advantage. **–JEREMY LAIRD**

VERDICT
6

Samsung 860 QVO 1TB

+ BIGGER QLC NAND bumps data density by 33 percent; well-established hardware platform.

– NOT BETTER Poor underlying performance of QLC NAND; not a lot cheaper than an MLC drive.

$138, www.samsung.com

BENCHMARKS

	Samsung 860 QVO 1TB	Samsung 860 Evo 500GB	Crucial BX500 120GB
30GB Internal Copy (Seconds)	124	**89**	224
CrystalDisk 6 Sequential Read/Write (MB/s)	562/531	**563/533**	561/238
Anvil 4K QD 1 Read/Write (MB/s)	25/91	**50/119**	31/112
Anvil 4K QD 2 Read/Write (MB/s)	27/**239**	**98**/225	53/197
Anvil 4K QD 4 Read/Write (MB/s)	48/**317**	**182**/314	87/207

Best scores are in bold. Our test bench consists of an Intel Core i7-8700K, an Asus Maximus X Hero, an Nvidia GeForce GTX 1080, 16GB of Corsair Dominator Platinum DDR4, and a Samsung 850 Evo 250GB OS SSD.

SPECIFICATIONS

Capacity	1TB
Interface	SATA 6Gb/s
Control Protocol	AHCI
Controller	Samsung MJX
NAND Type	Samsung 3D QLC NAND
Sequential Read/Write	560/520MB/s
Read/Write QD4 IOPS	97/89K
Warranty	Three years

SAMSUNG
Solid State Drive

Can Samsung's QLC SSD succeed where others have failed?

MAXIMUS XI
JOIN THE REPUBLIC
REPUBLIC OF GAMERS
MAXIMUS XI GENE
SUPREMEFX

It's pretty, but really very odd.

Asus ROG Maximus XI Gene

With great power comes a great price tag

LET'S CONTINUE with that subheader for a moment. $420 on Newegg; $423 on eBay. Anywhere else? Nope. At least, not that we can find at the time of writing. That's one painful price point. It's just $30 off the price of a Maximus XI Formula. You know, that motherboard with the super-advanced stat reading, OLED display, and integrated liquid-cooling VRM blocks. Knock $130 off that budget, and you could still get a Maximus XI Hero. Ouch!

We love the microATX form factor. It's the perfect compromise between the unreasonable physicality of ITX and the connectivity-laden chalice of ATX and above. It's the most blissful pairing, more often than not found in budget systems. We once mused about how few of these boards were out there, because the market is so minuscule in comparison to the other two segments. After all, better to commit one way than sit in the middle, and as Intel was throwing out processor updates every six months, there wasn't enough time to develop them. But, Asus, you're not helping with products like this. $420 on a motherboard?

So, why that price point? To be honest, there's not a whole lot to talk about. OK, let's get the big one out of the way first: As standard, the XI Gene supports double-capacity DDR4 sticks, an unverified variant of JEDEC's DDR4 standard. It packs in twice as many memory chips, on sticks twice as high, so you can max out at a theoretical 128GB of memory on a dual-channel quad DIMM slot Z390 system. That's pretty snazzy if you're into 8K rendering with After Effects, and prefer powerful single-core and iGPU rendering over the quad-channel bandwidth ridden multicore beasts littering the top end. Or at least, it would be snazzy for this board if Asus hadn't cut off two of the memory slots in favor of inserting a few extra M.2 slots in their place.

HIGHS AND LOWS

So, yeah, it's a motherboard that can support 64GB of DDR4—like all the other motherboards out there—but they're twice as high, and a bit rarer, and a lot more expensive, and the motherboard costs as much as an RTX 2070. But you do get more M.2 ports, so there's that. And it does come with a really nice heatsink, too, for those M.2s, which is good. Yep, very good.

Other than that, there's not a lot here. It's a microATX form factor, it packs twin eight-pin EPS, which is nice, and an integrated rear I/O plate, but the design itself isn't that dissimilar from the Maximus XI Hero we mentioned earlier. In fact, arguably, the only differences here stem from the fact that you lose out on two extra PCIe M.2 slots, and some extra goodness in the power management department. But if we're honest, having four M.2s on a mainstream platform doesn't make a whole lot of sense either, because the theoretical maximum bandwidth heading to the CPU is 3.94GB/s, or two Samsung 970 Pros running in RAID 0.

On the whole, though, performance is good, and although we don't understand Asus's logic with the spec of this board, in game and in our productivity benchmarks, it performs well, especially compared to the likes of MSI's $600 Godlike.

If you must have a super-premium microATX motherboard, the Gene is a good fit—just be ready to pay for it. Is it really worth it? Even as fans of the form factor, it's a hard sell. It looks great, it performs strongly, but on the whole, it's just so much money. Sorry, Asus, maybe next time. **–ZAK STOREY**

VERDICT

6

Asus ROG Maximus XI Gene

+ MONEY BAGS Strong performance; impressive aesthetic; heatsink; great connectivity.

– SCROOGE MCASUS Ridiculous design choices; over-the-top price; one PCIe slot.

$420, www.asus.com

BENCHMARKS

	Asus ROG Maximus XI Gene	MSI MEG Z390 Godlike
Tech ARP's X264 (Avg fps)	29.66	**30**
Cinebench R15 Multi (Index)	1,389	**1,424**
Fry Render (m:s)	**2:23**	**2:23**
AIDA64 Memory Latency (ns)	**47**	50.4
CrystalDisk QD32 Sequential Read (MB/s)	**550**	548
CrystalDisk QD32 Sequential Write (MB/s)	495	**523**
Power Draw Idle/Load (Watts)	**42/307**	50/310
Total War: Warhammer II (Avg fps)	**56**	**56**
Lowest Voltage @ 4GHz (Volts)	**1.22**	1.29
Maximum OC Achieved (GHz @ V)	**5.1 @ 1.32**	5.0 @ 1.29

Best scores are in bold. Our test bed consists of an Intel Core i7-8700K, 16GB of Corsair Dominator Platinum DDR4 @ 3,000MT/s, an Nvidia GeForce GTX 1080, and a 250GB Samsung 860 Evo SSD. *Total War: Warhammer II* was tested at 1440p, on the ultra preset.

SPECIFICATIONS

Chipset/Socket	Z390/LGA 1151
Form Factor	MicroATX
Memory Support	64GB (2x 32GB) DDR4 @ 4,600MHz
M.2/U.2 Support	4x M.2 PCIe SSD
SATA Support	4x SATA 6Gb/s
Max PCIe Support	1x PCIe 3.0 x16
Rear I/O	7x USB 3.1 Type A, 1x USB 3.1 Type C, 2x USB 2.0, PS/2 combi port, HDMI out, Intel Gigabit Ethernet, 5.1 audio, optical out, Wireless A/C, CMOS reset, BIOS reset

G2 ESPORTS
AOC

AOC's new gaming panel is aimed at esports, but misses the target elsewhere.

SIGNATURE EDITION

AOC G2590PX G2 Signature Edition

High refresh, limited usability

25-INCH TN PANEL? 1080p native resolution? For $370? Get lost. And that's putting it politely. But hang on—the problem is that specialist gaming monitors, like AOC's G2590PX G2 Signature Edition, suck in a productivity or media-consumption context.

That's true of an increasing number of PC components, but when it comes to monitors, the gap between multimedia and productivity panels, on one hand, and gaming monitors, on the other, has widened into a veritable chasm. Gaming monitors offer features, such as adaptive sync, that have pretty much zero value for productivity or media consumption. And what makes sense for productivity, such as very high native resolutions, can kibosh your gaming performance.

That's the context for AOC's latest gaming monitor. The "G2" bit refers to a branding tie-in with the multi-team esports organization of the same name, and implies this is a monitor meant for esports. That makes it about as narrowly focused as gaming monitors get. The consequence? Those baseline specs look deeply unappealing at $370.

For that price, you can have everything from a 40-inch 4K TV with HDMI 2.0 connectivity for big-screen fun to a quality 27-inch IPS screen with 1440p native resolution. Here, all it buys is 25 inches of TN panel, with a mere 1,920x1,080 resolution, and thus fewer than 100 pixels per inch. Yuck.

But hold on: AOC has packed this with some decent technology for gaming. First up, it'll run at fully 144Hz. That isn't exactly world-beating; BenQ's otherwise similar Zowie XL2540 does 240Hz, but costs significantly more. More to the point, it still gives you a great high-refresh experience. Next, you get adaptive sync in the form of FreeSync. Nvidia recently unlocked its GPUs to run with FreeSync, so you no longer need an AMD graphics card to get its action-smoothing benefits.

AOC has also fitted the G2590PX G2 with a low input lag mode and configurable pixel overdrive. This introduces image artefacts at its most aggressive setting, but at "medium," the result is the kind of zappy pixel response that esports addicts are after. Combined with that 144Hz refresh and the low input lag mode, and you have a seriously responsive display.

As for image quality, the default setting is washed out. A tweak of the gamma settings puts it right and reveals a reasonable level of saturation. The viewing angles are tragic compared to a modern IPS panel, and color accuracy is mediocre, but there's plenty of shadow detail, allowing you to pick out enemies.

With a native res of 1080p and a screen diagonal of 25 inches, the DPI works out to 90, which is fairly poor in a productivity context. But for gaming, 1080p means you don't need a megabucks graphics card to make the most of the 144Hz capability.

If you're hell-bent on a very gaming-centric monitor at this price point, the AOC G2590PX G2 has plenty going for it. For everyone else, even for those who play a fair few games but have at least one eye on productivity or watching video, the gaming goodness comes at too high a price in other areas. **–JEREMY LAIRD**

VERDICT

7

AOC G2590PX G2 Signature Edition

⊞ **GAME ON** 144Hz refresh, low input lag, adaptive, and good response times are a great gaming combo.

⊟ **GAME OVER** TN panel and 1080p native are a bummer for everything else.

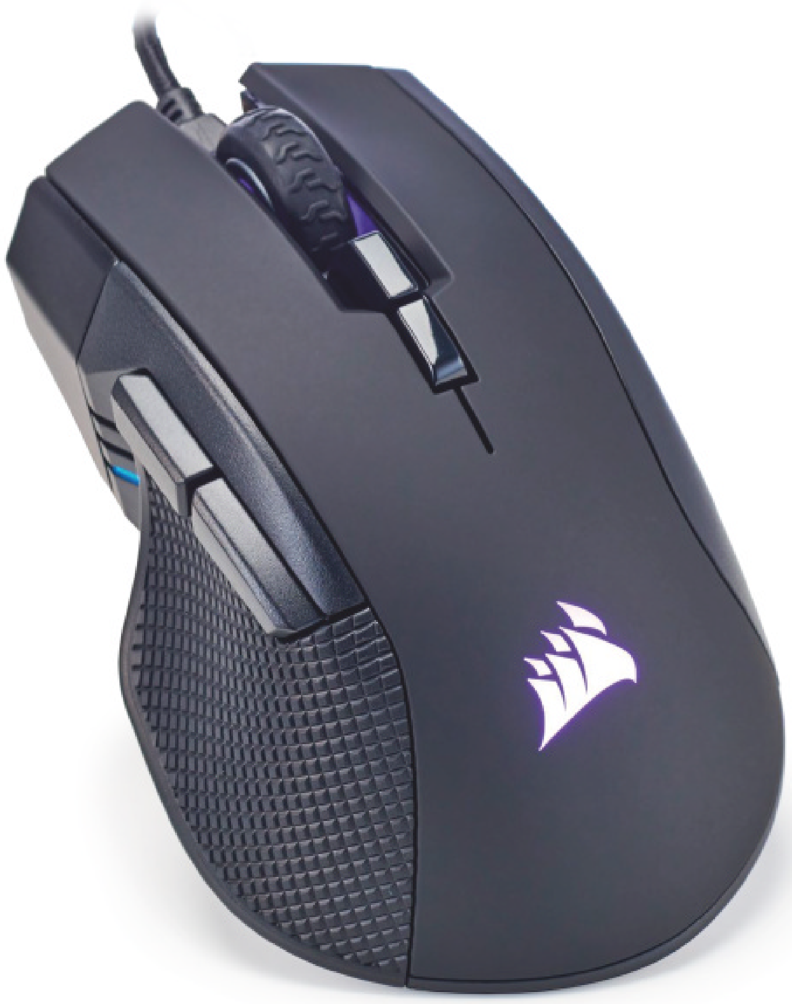
$370, http://us.aoc.com

SPECIFICATIONS

Panel Size	24.5-inch
Native Resolution	1920x1080
Pixel Density	90 ppi
Panel Type	TN
Maximum Refresh	144Hz
Response	1ms
Contrast	1,000:1
Display Inputs	DisplayPort, 2x HDMI
Connectivity	USB 3.0 x 4
VESA Mount	100x100mm
Warranty	Three years

Corsair Ironclaw RGB

A massive mouse with many meandering mounds



GRIP IS DEADLY important, particularly when applying the iron claw, once pro wrestling's most deadly submission hold. If you've not seen it, basically it involves contorting one's hand into a tense shape as if you're holding an invisible basketball while pretending to be a swamp monster, then placing that hand tenderly on to the bit of your opponent you've been attacking for the last 20 minutes. Perhaps you'll gingerly touch their abs, maybe their skull. Whatever the target, wrestling's iron claw elicits screams of pain.

Thankfully (and tenuously), Corsair hasn't taken even an ounce of inspiration from this mouse's namesake, beyond trying to make it a match winner. But we do need to question that name. If you're going to add "claw" to the title of your mouse, we'd have thought that would indicate that it's firmly in the claw grip category, but the molding here (particularly the fingertip-hugging dish-shaped tips of the main buttons) makes us feel the Ironclaw RGB is much better suited to palm grip. That's not so say you can't hook your fingers up, particularly when it's possible to actuate the buttons with a firm press way past the 50-yard line of its shell, but that comfort is hard to ignore. It's beautifully shaped, with the perfect top-line curve for this reviewer's slightly gigantic hands, backed up by the silky silicon coating so ubiquitous of mice at this price. Same caveat as usual, here: This is all well and good until the oils in your fingers start making it rub off or turn gummy a few years down the line.

That's only the top surface, too. The Ironclaw RGB's edges have curves for days, with a heavyweight knurled silicon ensuring your thumb and ring finger aren't going anywhere fast. The left edge is, toward the heel of the mouse, just slightly bulbous, contrasting with the concave shape many similar mice offer. That bump is, we assume, supposed to nestle nicely against the first joint of your thumb. That would depend on your thumb; the longer-thumbed might find it causes their wrist to twist during periods of intense play as that joint settles. Don't think we don't like it, though: This is the polar opposite of the half-baked edge coating we constantly complain about.

SEE THE LIGHT

The left edge is also home to a pair of large, easily accessed, and very pleasant secondary buttons. Where this often means a visit to sponge town, these are clicky and firm. Just below them is a three-light RGB indicator of sensitivity settings, which can be accessed using the two buttons on the top of the mouse. By default, the frontmost button flicks between three sensible settings, while the rear toggles three more extreme sensitivities for crazy people; as you might expect, this (and the lighting of the mouse wheel and palm logo) can be tinkered with in Corsair's iCUE app.

Even the mouse wheel is satisfying, with a tire-print finish ensuring grip, a very satisfying click to it, and just enough resistance to make its notching definite without being over-tense. The sensor, which totes an absurd top resolution of 18,000 dpi, is totally over-engineered, and caps off what is an absolutely excellent construction. But here's the but: Actually using the Ironclaw RGB brings up a few light issues. It's extra-wide, like an ice cream mouse that's been left out in the sun for a couple of minutes, which makes the dance across your mouse pad that little bit more difficult than with narrower pointers. The main buttons are, at their tips, very light to activate, which isn't to everyone's tastes. There's a grand total of one customizable RGB zone, nigh-invisible when the mouse is held, which is disappointing, given that color-tweaking is basically in the name. Those are minor bugbears, though; despite them all, the Ironclaw RGB is indeed a winner that will make you as deadly in gaming as Baron von Raschke was in the ring. **–ALEX COX**

VERDICT 8

Corsair Ironclaw RGB

+ CLAW Heavy, solid construction; a ridiculously sensitive sensor.

− PSHAW Not for every hand; quite wide; limited RGB.

$60, www.corsair.com

SPECIFICATIONS

Sensor	Corsair-custom (Pixart)
Sensitivity	18,000 dpi
Sensor Model	PMW3391
Polling Rate	1,000Hz (max)
Programmable Buttons	7
LEDs	One-zone RGB
Cable Length	6 feet
Weight	3.8oz

Razer BlackWidow Lite

A real work of (quiet) genius

"NOTHING STRENGTHENS authority so much as silence," remarked Leonardo da Vinci, no doubt when working on his greatest invention, the mechanical keyboard. There are some who would argue against the bearded old master—Michelangelo, according to our dubious renaissance sources, liked a serious clack to his keys—but the philosophy still has legs. If you want to game hard without distraction, if you want to treat your fingers to a quality keyboard in an office that won't tolerate the sound of a thousand snaps a second, if you're often streaming or making voice calls while typing, a silent switch is the solution.

Razer has taken more than one bite at the silent cherry. We've looked at its yellow switches before, and probably used adjectives like "horrible," "swampy," or "disgusting" while doing so. As you might imagine, we don't think they're particularly great. Tested here in the BlackWidow Lite, though, we have the notched orange variety. They're pretty much the polar opposite of the yellows: definite, firm, with a notch that's slightly more resistive that its closest rival, the Cherry MX Brown. These switches feel absolutely superb, not quite as sharp (or, naturally, as snappy) as the Razer green switch, but you know when they've been actuated. If we had one complaint, they can be a little rough on the upstroke, with quite a heavy spring—if you don't tend to retract your fingers from the key caps, this might prove annoying.

Silent though the switches themselves may be, this isn't an entirely silent keyboard. There's a little tap to be heard as the stalk of these needlessly low-profile key caps (we think it's an entirely aesthetic choice) bottom out on the switches; Razer thoughtfully includes a big bag of grommets, which almost completely alleviates this particular sound if you're willing to put up with the solid bottom-out being replaced by a disappointing rubbery one. The grommets also can't do away with the pop of these well-sprung keys returning to zero, so true stealth typing is out of the question. We should give a bit of page acreage to the space bar here, too: There's not an ounce of the usual rattle. While it's acoustically different from the rest of the keys, it's one of the best space bars we've ever used. That's a phrase we don't utter often.

In terms of its looks, the BlackWidow Lite is a keyboard worthy of a sketch in Da Vinci's notebook; it has some of the cleanest lines around, with a minimal round-edged bezel surrounding the keys, individually lit switches (white only, though you can tweak the brightness), with lenses over each LED to diffract the beam, a detachable cable, and a cool matt finish that means the combo isn't harsh on the eyes even at full brightness. There's no wasted decoration; were it not for the signature key cap font and the barely perceptible Razer logo (and, er, the box), we'd not have pinned this as a Razer keyboard at all. A company with a reputation for brashness putting out a wonderfully understated keyboard? It's like dogs and cats living together.

Perhaps, though, that understatement has gone a little too far. If this is a keyboard doing double duty on the desktop and driving gaming, it doesn't do the best job of fulfilling the needs of the former. There's no number pad; yes, that's sort of the point of a tenkeyless keyboard, but they do come in damn useful. Media keys are on an FN shortcut rather than being dedicated buttons. There's not even a half-hearted plastic wrist rest included. Sounds like we're being picky, but there's a world of well-equipped keyboards out there that double up just as well, with number pads, too, all at a similar price. It's almost like old Leonardo's flapping-wing flying machine: Beautiful design, impeccable ideas behind it, but it just doesn't quite work the way it was intended to. **–ALEX COX**

VERDICT 7

Razer BlackWidow Lite

⊞ **SILENT** Pleasant key feel; calm, cool design; solid construction.

⊟ **VIOLENT** Few additional features.

$90, www.razer.com

SPECIFICATIONS

Switch Type	Razer Orange
Form Factor	Tenkeyless
Media Keys	With FN
Macro Keys	Programmable
LEDs	White
N-Key Rollover	10-key
Pass-Through	No
Dimensions	5.2 x 14.2 x 1.4 inches
Warranty	Two years

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Thermaltake A500 TG

Aiming for pay dirt with aluminum

thermaltake

THE $200+ CASE MARKET right now is a pretty tough old girl to get your claws into as a manufacturer. It's littered with award-winning hyper-towers from the likes of Phanteks, Cooler Master, NZXT, and more, and as reputations go, they've earned theirs through blood, sweat, and a ton of development. So, when we say that Thermaltake might be on to something with the A500 TG, you can guess how this is going to go.

It's a dangerous part of the market, for sure, but nonetheless, Thermaltake has attacked it with vigor. The A500 TG is a mixing pot of slick brushed aluminum, pressed steel, and tempered glass panels. It features the type of intuitive design choices, quality materials, and impressive engineering that we've not seen from the brand for some time.

Both of the tempered glass side panels sit flush to the frame. There are no clunky securing mechanisms or thumbscrews here, just two sets of magnets, located top and bottom, to hold the twin glass panels in place, followed by a simple turning latch. Both panels are removable—you simply have to lift them off the hinges—and both are ridiculously easy to place back on. They're weighty, too, so to see them sitting so flush to the chassis, without suffering from any sag, is a credit both to the design of the hinges and to the overall engineering involved in this case.

The internal chassis is steel, of course—that's to be expected—however, it's perhaps the only part of the A500 TG that lets it down. It's not all doom and gloom, but it's a little less modern than we'd like. Removable hard drive cages litter the front of the case, restricting airflow from the pre-installed fans, despite the fact there are two hard drive caddies in the bottom already. On top of that, there are only three rubber grommets for the cable cutouts, no removable radiator trays front or top, and a severe lack of smart cable management in the back. Incredibly (it's hard to believe we're actually complaining about this), there's also no sign of any LED lighting anywhere inside, which isn't necessarily a problem, but at this price point, you'd expect at least something classy to match that exterior design.

Cooling is a bit of a tricky one on the whole. The A500 TG does support a substantial number of fans: You can install up to three 140mm fans in the front, three 120mm ones in the roof (or two 140mm), and a single 120mm fan in the rear, with all three locations supporting their respective combined radiator sizes as well. There are plenty of mounting holes to install them into, but again, no removable radiator brackets. As far as performance goes, this case is going to prefer an AIO solution to a fully liquid-cooled setup. That's not to say it's impossible to fit a fully liquid-cooled build here, but you would be limited when it comes to radiator size. In fact, it's best to stick to the slim ones, especially if you plan on running push-pull.

The big problem, however, is that closed-off front panel. Although you do get some mesh filters baked into the one-inch-deep side channels found on both the front panel and the roof, it's not enough to provide substantial airflow to those radiators we mentioned earlier. They're also not removable from the case, meaning you will have to pull the entire roof and front panels off your case to clean them.

Overall, the A500 TG looks amazing. It's a case that has impressed us with its design and material use; however, there are just a few too many oversights for us to give it the whole nine yards when it comes to our awards. It's a nice, solid case, but can it dethrone the likes of Phanteks and co? We're not convinced just yet. –ZAK STOREY

VERDICT
8

Thermaltake A500 TG

⊞ **AT-AT** Impressive use of materials; fairly strong price range; great build quality.

⊟ **REBEL SCUM** Cooling needs work; more internal features please.

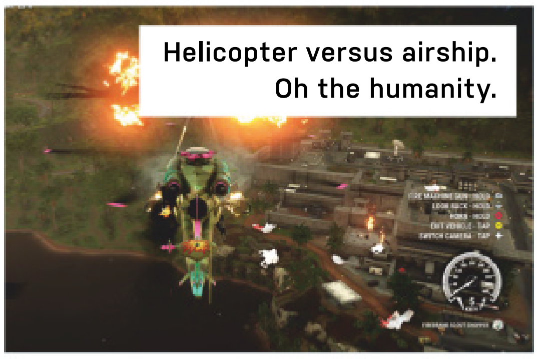
$245, www.thermaltake.com

SPECIFICATIONS

Form Factor	Mid-tower
Motherboard Support	ATX, microATX, ITX
Colors Available	Space gray
Window Available	Only windowed
3.5-inch Support	6 (hard drive caddies)
2.5-inch Support	6+1 (hard drive caddies + bracket)
Radiator Support	420mm front, 360mm roof, 120mm rear
Fan Support	3x 140mm front, 3x 120mm roof, 1x 120mm rear
Dimensions	22 x 9.3 x 20.1 inches
Graphics Card Clearance	11.6/16.5 inches (with/without HDD cage)
CPU Tower Clearance	6.3 inches
Weight	32.7lb

Preorder codes give access to a prototype wingsuit with missile launchers.

The parachute is a sedate way to enjoy the scenery.



Helicopter versus airship. Oh the humanity.

Car + balloon = floaty fun.

Just Cause 4

Gleeful explosive chaos gains a new strategic edge

REVIEWS OF JUST CAUSE games often revolve around anecdotes, usually involving tethering things together before launching them into the air or making them go boom. *Just Cause 4* will lead to more such stories, as nothing creates moments of chaos and flying debris like one-man-army Rico's frequent battles against bad men with private armies.

Underneath the playful physics and new weaponized weather effects, it's another base-clearing open-world game starring a freelance dictator-removal specialist, but this time mixed up with a strange movie-making narrative that withholds 100 percent completed status in zones until you've done some stunts or killed some people for the cameras.

There are other changes too. Instead of simply running around blowing things up and bringing down inexhaustible numbers of soldiers, *JC4* complicates things. There are strategy-game elements to the map screen, as you juggle squads of partisans to advance the frontline of your insurgency across the lush South-American island. The map is generally fine, though doesn't zoom out far enough, but adds layers of complication to the game it didn't need.

There are also new options for the game's trademark grappling hook, which allow you to attach rockets, balloons, and retractable tethers to things, and control whether these effects happen automatically or via a button press. It's all accessed through the map screen in much the same way as *Assassin's Creed Odyssey*, but doesn't explain itself so well.

Once in the jungle, using the grappling hook, parachute, and wingsuit to traverse the environment is still a joy, as is gunning down enemies and creating explosions. Tethering an enemy APC to balloons and rocket motors so it floats off then zooms into the distance is not only possible, but encouraged. There are flashes of the old *Just Cause* here, but it's never really clear what you have to do to progress.

It can be good looking, and is forgiving in its system requirements, but there are issues. We watched perfectly straight lines appear across rivers, just so the textures on one side could flicker on and off. We saw NPC drivers pile into one another at the first sign of anything blocking the road. And we marveled at a flock of birds appearing in the sky like a firework before flapping their stiff wings. Cutscenes appear to be lower resolution than the gameplay. On-screen control prompts can't be turned off. We watched all this intently because we couldn't hear anything—the sound disappeared a few missions ago. (It's strange how a lack of sound focuses the mind on the vibrations of your controller, which might have got stuck on—it's hard to tell when there's so much shooting and exploding). The subtitles quit, too, and we're reliant on the mission markers and descriptions to tell us what's going on. Then we get to a mission with a marker up in the clouds and, even in a game with this much verticality, we wonder what's going on.

It's the nature of modern PC games to be patched, of course, and perhaps shipping like this is a reflection of the series's brand of dumb anarchy, but for now, the game lets itself down when it should be riding a whooping tornado of chaos into the dictator's lair. **–IAN EVENDEN**

VERDICT 6

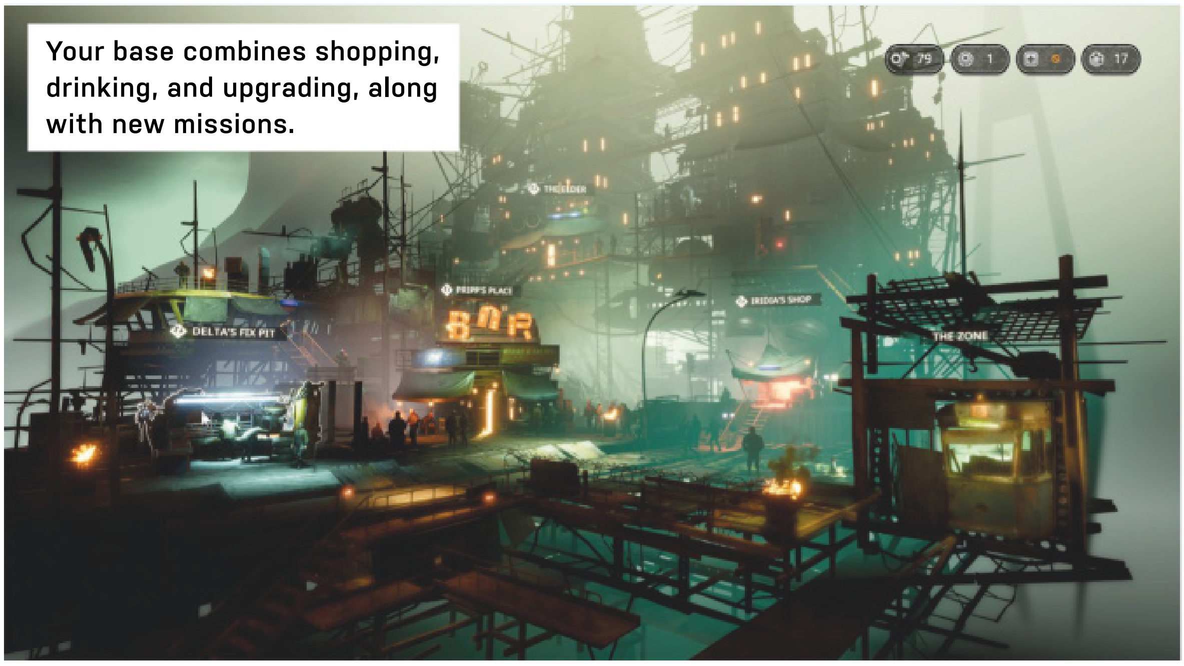
Just Cause 4

➕ **PARACHUTED** Fun chaos; lots of weapons and vehicles; looks pretty good.

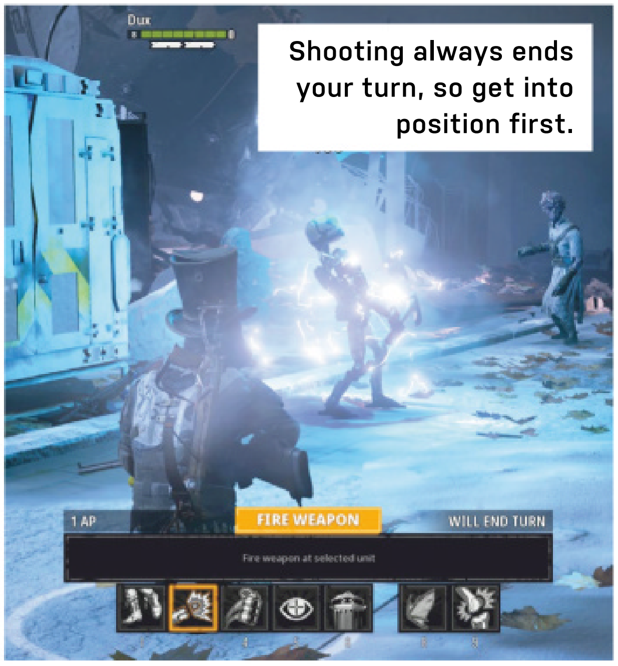
➖ **CONVOLUTED** Unnecessary complications; bugs; disappointing weather control.

RECOMMENDED SPECS Core i7-4770/Ryzen 5 1600; 16GB RAM; GTX 1070/Vega 64.

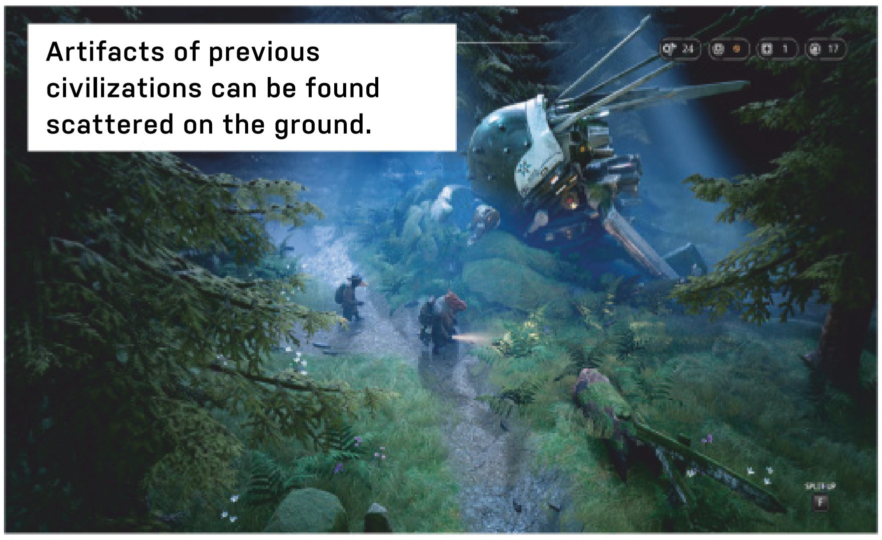
$60, http://square-enix-games.com, ESRB: M



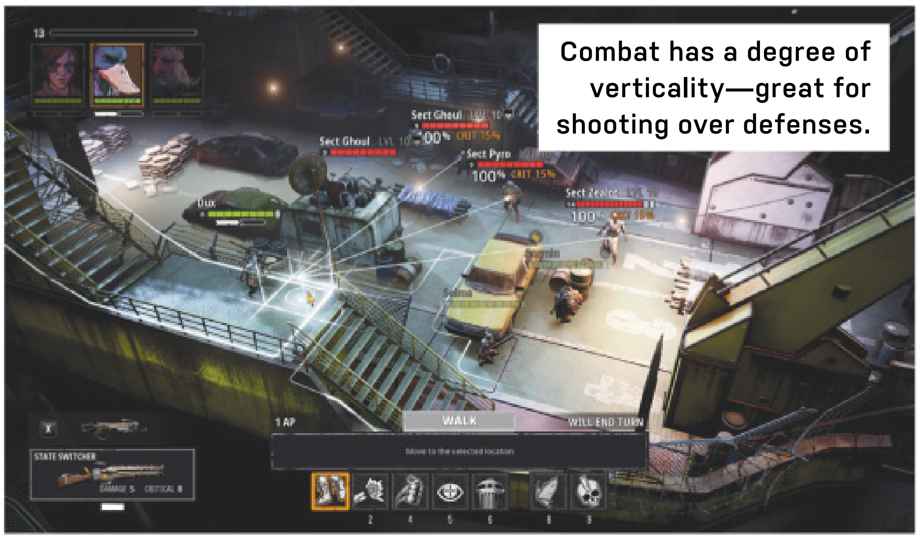
Your base combines shopping, drinking, and upgrading, along with new missions.



Shooting always ends your turn, so get into position first.



Artifacts of previous civilizations can be found scattered on the ground.



Combat has a degree of verticality—great for shooting over defenses.

Mutant Year Zero: Road to Eden

How do you stay warm behind cover? Duck down

XCOM, BUT WITH A TALKING DUCK, is a fine elevator pitch, and might have been enough on its own to get this greenlit. But *Mutant Year Zero's* Swedish developer has taken the source material—a pen and paper RPG we hadn't heard of—and built something wonderful on top.

There's also a talking pig, along with a sniper fox who sounds like she came from *Metal Gear Solid*. You can mutate them in many ways, from stone skin that shrugs off damage to gigantic moth wings, taking flight to improve line of sight to target in the same way *XCOM's* snipers could.

There's a lot of *XCOM* about the game, with differing levels of cover, overwatch, hit percentages, and weapon mods, but *Mutant* sprouts enough of its own pseudopods to stand out. While combat is turn-based, exploration is done in real time, and there's a focus on stealth as you order characters to douse their flashlights and hunker down when you think enemies are near. *XCOM's* infiltration missions are mirrored in the way you can set up ambushes, but *Mutant's* are less satisfying, particularly early on when your best gun holds only one shot.

The difficulty makes stealthy planning a necessity, and it's upsetting to have your strategy undermined by enemies who call for reinforcements who appear from behind, when you've carefully picked your cover positions to defend against a frontal assault. The importance of ambushes also makes battles play out in similar ways—you sneak up, deliver a blow from cover, then mop up. Unless the ambush went wrong, in which case you restart.

Where the game does win out is in personality. The world-building sees mutants scratching a living hundreds of years after a non-specific catastrophe, the ruins of human civilization still visible, but being reclaimed by plant life. It's an artful, well-designed game that encourages you to explore by dotting loot around—but then forces you to take it back to base before using it to upgrade. Thankfully, there's a fast travel system.

It's also well written, the voice acting and enemy barks raising many smiles before becoming repetitive. It continues adding enemies well past its mid-point, but becomes too reliant on beefing them up with additional hitpoints, and has little niggles, such as the mouse wheel doing nothing when you expect it to zoom out.

Overall, *Mutant's* world is a fun place to explore, and its characters are well rounded and well written. However, it feels as though it doesn't quite deliver on its potential, progressing too slowly, with too much aimless wandering about, and too many failed ambushes, to be the kind of success a game featuring a talking duck deserves. **–IAN EVENDEN**

VERDICT
7

Mutant Year Zero: Road to Eden

+ DUCK Looks great; low system specs; well written and acted.

– PIG Frustrating ambushes; small maps; slow progress.

RECOMMENDED SPECS Core i7-6700K/ Ryzen 5 1600X; 8GB RAM; GTX 970/RX 480.

$35, www.mutantyearzero.com, ESRB: M

LAB NOTES

ALAN DEXTER, EXECUTIVE EDITOR

RT Ray Tracing Needs a Killer App

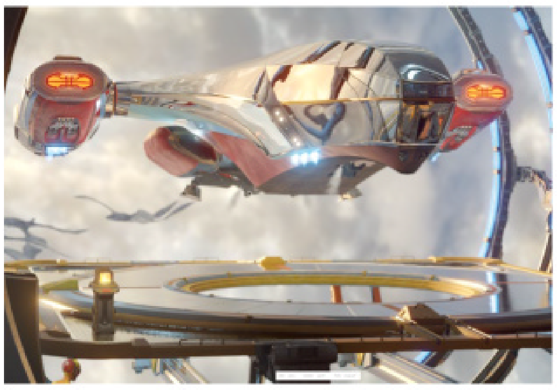
We still need a reason to buy RTX graphics cards

THE NVIDIA RTX 2080 TI was officially released on September 20, 2018, but at the time of writing, here we are, four months later, still waiting for a reason to drop money on one. So far, there's been one game released that makes use of the new technology, and *Battlefield V* is hardly the sort of game where you can really appreciate what the new technology is capable of. In our experience, the franchise benefits more from silky smooth frame rates than beautifully rendered puddles.

What we do have is a new benchmark to get our collective heads around: 3DMark's Port Royal test. This synthetic, non-interactive benchmark does a good job of showing off some of the things that real-time ray tracing is capable of, with the spaceship's mirrored hull being particularly impressive to behold. It's also an important step forward for the tech, because it means we have a hardware test that is easily repeatable—something that is tricky when using an actual game, where repeating the exact same sequence of events is effectively impossible.

There are some interesting takeaways here, though, not least of which is the benchmark's default resolution of 1440p. On the ROG Strix GeForce RTX 2080 Ti OC edition Asus loaned us for testing, we hit 35fps at the default resolution. Up that to 4K, and you'll be sitting in the low teens, which shows how important resolution is for ray tracing. For reference, the default 1440p test using the more affordable GeForce RTX 2060 has an average frame rate of just 17fps.

Obviously, balancing the visual impact of a game with smoothness is something that developers are going to have to hit perfectly for real-time ray tracing to stand a chance with these first-generation cards. However, it does feel as though the odds are stacked against them at this stage.



3DMark's Port Royal benchmark showcases the capabilities of real-time ray tracing.

JARRED WALTON

Senior Editor

Everybody needs a little time away, or so they say. I did just that in rural Star Valley, Wyoming, on a snowmobiling trip with my brothers. To prepare, I ran a bunch of benchmarks on *PUBG's* new Vikendi map, which lets you ride snowmobiles. It was the perfect setup, but I learned some things on the trip. For one, riding a snowmobile—and avoiding getting stuck in the deep powder—can be tricky. *PUBG* utterly fails to simulate this properly. Face up a moderately steep hill and punch the throttle, and you can sink the treads several feet into the powder in a second. A corollary to this is that digging out a 450lb sled is hard—thankfully, no one was trying to line up a headshot, as I was a sitting duck for 30 minutes or longer on multiple occasions.

But the most painful lesson came from a branch. In *PUBG*, you slam into a building or large tree, and you come to an abrupt stop, perhaps with some bouncing around of your view, and a flash of red to simulate damage. Smaller trees and branches are "invisible," and you can go right through them. But a one-inch-thick branch taught me a different story. It took my helmet clean off and sent me flying, with some good scratches and bruises as a souvenir. Ouch.

I think I'd better stick with virtual snowmobiles for now.

Editors' Picks:
Digital Discoveries

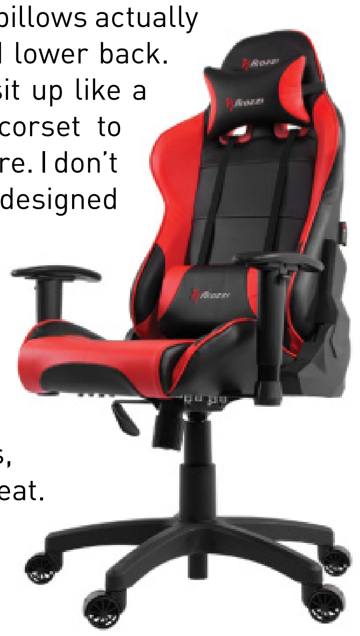
Hardware staff writer, Joanna Nelius, and hardware lead, Bo Moore, share what's been helping them relax

AROZZI VERONA JUNIOR GAMING CHAIR

Between various jobs, reviewing games, and writing my own stories, I'd already spent a lot of time sitting in front of a computer long before joining *Maximum PC.* Years of having bad posture at the keyboard caught up to me. I started getting muscle spasms in my shoulder blades. All the muscles in my lower back felt like worn-out rubber bands. So, I started sitting up pin-straight in my chair.

It's difficult to maintain that kind of posture for over eight hours a day, if not impossible. I didn't hurt as much, but I realized that the other issue was my chair. Sure, it was some expensive, ergonomic chair that could adjust in more directions than a Wonkavator, but it was too big.

Few gaming peripherals are made with smaller people in mind, and chairs are my nemesis—but then I sat in Arozzi's Verona Junior Gaming Chair. It's technically a kid's chair, but for a petite woman like myself, it feels custom-made. The head and lower back pillows actually hit my head and lower back. I don't have to sit up like a I'm wearing a corset to have good posture. I don't care if it was designed for kids. It feels good to sit comfortably. Now, if car makers would put adjustable pedals in cars, that would be great. $249, www.arozzi.com

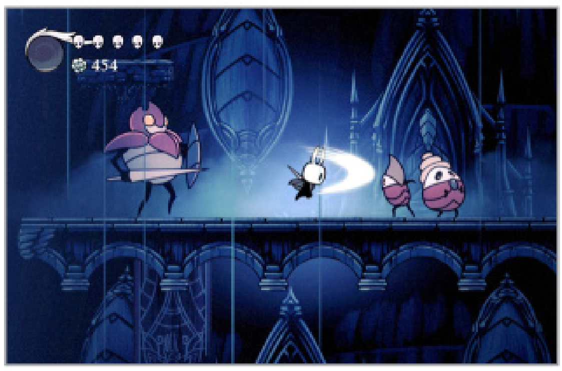


HOLLOW KNIGHT

I'm continuing my trend of picking up great PC games more than a year after release (specifically, once they arrive on Switch). This time, I'm heavily into *Hollow Knight,* which I just finished putting about 50-odd hours into, and am currently sitting at 105 percent completion. (It goes above 100 percent due to DLC content.)

Hollow Knight is a game that my friends and colleagues raved about at launch, but I wasn't super-interested in playing a metroidvania on PC. Instead, I waited for the Switch release, which finally arrived in mid-2018, right around the time I was deep in *Into the Breach.* After clearing out a few other games from my backlog, I finally picked up *Hollow Knight* over the holidays, and I haven't put it down since.

The game is damn hard, with tight platforming and challenging enemies, but most have a pattern to their combat that makes encounters more of a puzzle to solve than a fight to win. It's also dripping with setting, and tells its story much more through your exploration of the world rather than any one line of dialogue. I'm reaching the end now, but I still have a few boss fights to tackle and secrets to uncover. I can't recommend it enough. $15, www.hollowknight.com



GEEK TESTED & APPROVED

Netgear Nighthawk M1

THE NIGHTHAWK M1 is a Gigabit LTE mobile router, capable of connecting up to 20 devices to afford Internet access where you wouldn't normally get it. It's a great little unit if you're on the road. It can tell you how many devices are connected, as well as how much of your data allowance you've used.

In theory, it supports up to 1Gb/s downloads and 150Mb/s uploads, although your own experiences will depend on the network you're using, and where you're using it. If you're off the beaten track, you may not get much in the way of a network at all, while those in metropolitan areas can find themselves fighting for bandwidth along with everyone else.

Setup is easy: Pop the base off, slide your SIM into place, and then the battery, clip it all back together, hold the power button for three seconds, and you're up and running. Connecting to the M1 from smartphones or laptops is a simple case of selecting the corresponding SSID, and entering the password displayed on the LCD. You can connect a USB stick to it to share media between connected devices, too. You can also plumb it into your existing network via the Ethernet port and use it as a router, if you wish, although why you'd want to isn't quite so obvious.

Overall, while a bit pricey, as you need a quality network plan, it's still an impressive bit of tech. And for those on the road, it could well be a life (or, more realistically, business) saver. **–AD**
$199, www.netgear.com

LETTERS

WE TACKLE TOUGH READER QUESTIONS ON...

> Bargain Hunting
> Translation Tips
> Cool Running

Refurbed Rig

I recently had to do something that I wasn't planning on doing for a few months yet. I was planning on a "bargain hunting build" upgrade in May of this year, but my system was having some boot and system freeze issues that I was not able to diagnose, which started in December. They were very intermittent, and the messages and logs weren't all that helpful. My guess was motherboard or HDD issues, but SMART wasn't pointing out any problems.

So, I had to upgrade and went hunting for an office-centric refurb.

To my surprise, prices have increased for such refurbs. Back when I bought my previous refurb in 2010, you could get one with a one-year-old CPU, like the Athlon II X2 240 originally in my old machine, for around $300! Not now. I reckon the refurbers have figured out there's a market of us "get a cheap office-centric refurb and slap a few cheap upgrades into it" people, and have upped prices.

Office refurbs come in a lot of configurations, and you have to double-check that you're not getting one of the SFF models of machines that also come in smaller form factors—always use "tower" in your search.

Strangely, the Xeon-based machines were sometimes the cheapest. I was hoping to get a relatively recent quad-core i7 or Ryzen, but not on the $450 or less budget I set. It seemed like I'd have to settle for a third-generation Core i7, something like a 3770, but then I found that the HP machines with fourth-generations were cheaper than the OptiPlexes with the same.

That is probably because the HP machines are quirky. I finally settled on an HP EliteDesk 800 G1 with a plain i7-4790 (not the K version), 16GB of RAM, and a 2TB HDD. I could have saved some money by getting a machine with less RAM and transferring my RAM from my old machine, but I wanted 16GB so I could add my existing 16GB, and take it to 32GB.

After I ordered it, I was out at the local Walmart, doing my weekly shopping, and picked up a new external drive to do my system backup. Yeah, I have one, but it's partitioned in a specific way for use with some media devices (the PS4 and PS3), and I wanted one to format ext4. Lo and behold, Walmart has SSDs. Sure, they're basic WD Blues—they don't even come with a SATA cable—but it was right there, and I could have it ready for when the machine arrived.

Now, when the machine arrived, that's when I noticed the quirks not mentioned in the reviews.

This HP machine uses a non-standard power supply and motherboard/supply connectors; if you want to use a standard ATX supply, you need an adapter cable (and maybe have to re-pin the adapter cable, depending on the model), and some kind of adapter bracket to fit the smaller ATX supply in. Which means I haven't been able to put my Cooler Master 550W supply in yet (I don't have a bracket). But the installed 320W supply is enough for my GTX 1050 Ti, so it's not really a big deal.

Also, the drive bays are quick release, slide-in, slide-out types. If you want to put a 2.5-inch SSD in there, you either need a 2.5-to-3.5-inch bracket, or the special M3 slide-in screws. Or both, because some mounting brackets don't include the special screws for slide-in bays. The machine does include screws in handy spots inside the case for 3.5-inch drives and for adding another optical drive.

It also supplies SATA power from the motherboard, not directly from the power supply, which is nice, and reduces cable clutter. And the motherboard is well laid out and easy to work with, and the documentation for maintenance is clear and informative. You won't have to worry about scrapes or cuts working on this.

You can even install a video card (or other PCIe card) without having to pry free slot covers, or need to use a Torx screwdriver on the metal bracket that secures the cards. You flip a couple of latches, then just slide the slot covers out. Even popping the cover is as easy as pulling a handle; no Torx screwdriver needed. Not only that,

↘ submit your questions to: comments@maximumpc.com but the front audio jacks support both single unified jack and separate split mic/headphone jack headphones.

Except for the power supply, the machine is pleasant to work on.

I put in the SSD, added the cable, connected the SSD as primary, the 2TB HDD as secondary, and just laid it in there until I received the necessary slide-in screws. I put the XFCE Fedora 29 spin disc in and installed. Install went fine, I restored my "/home" from the Déjà Dup backup, and everything was pretty much back to normal.

I highly recommend trying out a refurb build once; though double-check what power supply the machine uses, and make sure you're getting a tower and not a small form factor or ultra-slim. **–Ron Rogers**

EXECUTIVE EDITOR, ALAN DEXTER, RESPONDS: Non-standard power supply aside, it sounds as though you managed to pick up quite the bargain—good work.

Dragon King

I'm a long-time subscriber to *Maximum PC*, and like it a lot. In the "Tech Porn" column on pages 46–47 of your January 2019 issue, there's a description of the Asus ROG Ryujin 360. The writer seems confused about the word "Ryujin" as part of the name of the device, so I thought I'd help. The word is obviously Japanese, which is a bit odd since Asus is a Taiwanese company, or at least was the last time I checked. (My mobo is Asus, in fact.) Ryujin means "dragon god" or "dragon king" in Japanese, and technically should be written as ryūjin, with a macron over the "u" because it's a long vowel (vowel length is very important in Japanese). The word can also mean "Dragovian," a race of characters in the video game *Dragon Quest III*. I've never played this game, so I am unfamiliar with this. In any case, I hope this helps.

–Richard Markley

If you're having problems tracking down the Enermax Liqtech TR4, try searching by its product code: ELC-LTTR240-TBP.

EXECUTIVE EDITOR, ALAN DEXTER, RESPONDS: I'll happily admit that Japanese isn't my strong point, although I'd guess I'm not alone in this, so hopefully it isn't just me who has learned something here. Of course, this now has us wondering why a Taiwanese company is using a Japanese word for dragon on a water cooler, but it's certainly not the strangest name we've ever seen in tech. Thanks for the info.

Cool Your Threads

I'm confused about the exact model of the liquid cooler you have listed on your Turbo system config at the end of the latest issue. It reads as Enermax Liqtech TR4 II 240mm RGB, but there doesn't seem to be a 240mm size associated with that model. There also seems to be a 280 that's more expensive, but like the other model, the prices are wildly different, and the specifications are vague on the retail sites. Could you please update me on the best liquid cooler for Threadripper? Thanks.

–Ryan Harris

EXECUTIVE EDITOR, ALAN DEXTER, RESPONDS: We can assure you that the Enermax Liqtech TR4 II exists—we've got one here. You can buy your own from plenty of sources, including Newegg (https://bit.ly/2TfLa8W), although you may want to pick up the triple-fan version, depending on which Threadripper you're looking to cool. It still feels relatively early days for keeping AMD Threadripper CPUs cool, and we haven't seen enough solutions from the bigger names. We also suggest that you don't discount traditional air coolers, such as the NH-U14s TR4-SP3.

Define "Essential"

After having a massively busy 2018 that caused me to fall way behind on my print periodicals, I've been playing catch-up in 2019. I've just read the July 2018 issue, and take issue with OneTab as an "essential" Chrome extension (pg. 20). Not that OneTab doesn't do what it says, just that it doesn't do it as well as Session Buddy, which does a much better job of managing named "sessions" (essentially link pages, like OneTab, only a lot more flexible).

Take a long look at Session Buddy, and you'll see why it's earned a five-star rating on the Chrome Web Store. **–Will Pearce**

EXECUTIVE EDITOR, ALAN DEXTER, RESPONDS: Thanks for the recommendation.

Visual Search Again

Rob S rightly complained about the lack of visual feedback when "searching" in Amazon Prime (January 2019). The fact that video doesn't update as you forward or rewind a show makes the service difficult to use. However, I think he's mistaken in blaming his Sony UltraHD Blu-ray. The problem isn't the streaming device running the Amazon Prime app—it's the app itself, which in my experience, lacks such visual feedback on all devices. Sony isn't responsible for the app's functionality, Amazon is.

The model for visual feedback on streaming services is Netflix, and it's a mystery why its competitors don't copy how it handles forwarding and rewinding. Of course, no one's perfect; Netflix is notorious for making it difficult to discover what content is buried in its service. Maybe Netflix needs to copy Google.

–Robert Tortorelli

EXECUTIVE EDITOR, ALAN DEXTER, RESPONDS: Since printing Rob S's letter, I've found myself more and more in agreement with him, and now you, in that Amazon's app really needs some work when it comes to visual searching—having to rewind a few seconds is surprisingly frustrating. You're right as well that Netflix handles this side of things in a far more convincing way, although falls down when it comes to discoverability.

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INGREDIENTS

PART		PRICE
Case	BitFenix Nova TG	$55
PSU	450W EVGA 450 BT 80+ Bronze	$30
Mobo	ASRock AB350M AM4 **NEW**	$55
CPU	AMD Ryzen 5 2600	$165
GPU	Gigabyte GeForce GTX 1060 3GB	$190
RAM	8GB (2x 4GB) Patriot Viper 4 @ 3,000MT/s	$60
SSD	120GB ADATA Ultimate SU650 2.5-inch SSD **NEW**	$25
HDD	1TB Western Digital RE3 3.5-inch HDD **NEW**	$36
OS	Ubuntu Desktop Linux 18.04 LTS 64-bit	$16

Approximate Price: $632

THAT'S DARN IMPRESSIVE: We managed to shave a total of $3 off the final cost of this build, and swapped out three major components at the same time. That's surprising, because given Nvidia's latest release, we expected the GTX 1060 to either hit EOL stock limits, and in turn shoot up, or the prices to shift regardless—but, nope, it actually reduced, and you get a *Fortnite* bundle, too, whatever that is. So, swapsies? Well, we've gone for a better spec motherboard this time around, ditching the no-longer-available AB320 ASRock mobo for an AB350M instead. It's a slightly higher specced chipset, with slightly better connectivity, and it only cost us $5 extra, so no hardships there, then. We saved $10 on the GPU, which helped negate the last two new swap-outs as well. We went for a 120GB ADATA SSD this time, the SU650—none of that QLC nonsense—along with a WD RE3 1TB hard drive.

MID-RANGE

INGREDIENTS

PART		PRICE
Case	Fractal Design Meshify C	$90
PSU	550W EVGA SuperNOVA 550 G3 80+ Gold **NEW**	$60
Mobo	Asus ROG Strix B450-F Gaming	$130
CPU	AMD Ryzen 7 2700	$260
Cooler	Corsair Hydro H100i Pro 240mm RGB AIO	$110
GPU	Zotac Gaming GeForce RTX 2060 6GB **NEW**	$350
RAM	16GB (2x 8GB) G.Skill Aegis @ 3,000MT/s	$95
SSD	250GB Samsung 970 Evo M.2 PCIe SSD	$90
HDD	1TB Western Digital RE3 3.5-inch HDD **NEW**	$36
OS	Windows 10 Home 64-bit OEM	$100

Approximate Price: $1,321

IT REALLY ANNOYS US WHEN GPU prices skyrocket—PTSD from the cryptocurrency boom, no doubt. But, seriously, our Asus GTX 1070 we used last issue (because 1070 Ti prices had started to skyrocket) is now $135 more than before. We wonder why that might be…. Yep. So, begrudgingly, we've picked up the Zotac's GeForce RTX 2060 6GB instead. Slightly less memory than last issue's card, but on a par with the issue prior to that's 1070 Ti GPU, at least in terms of performance—unless you like pretty puddles in *Battlefield*, of course (here's hoping some more ray-tracing titles come soon). Fortunately, pricing hasn't fluctuated too much elsewhere. We did lose out on the GPU—$20 more, purely down to the fact it was one of the cheapest dual-fan RTX 2060s we could find—but we managed to knock $10 off the PSU price by upgrading to the G3 edition of the 550W EVGA PSU, as opposed to the G2.

TURBO

UPGRADE OF THE MONTH

NVIDIA GEFORCE RTX 2060

Yep, we spend an entire issue moaning about it, but still recommend it as "Upgrade of the Month." It's difficult to compete with this right now—the fact you can find it for less than $350 makes it impeccable value for money. It's a very strong 1440p gaming card, and with the added bonus of DLSS and potentially some ray-tracing elements in the future, it has a strong footing for the days to come.

Unlike its top-heavy brethren, we've yet to hear of anything going wrong with these cards with regard to memory burn-out either (although it is early days), so hopefully there should be far fewer RMAs than we saw with the first gen.

$350, www.nvidia.com

OH SWEET, SWEET SAVINGS. Sometimes, it's difficult to keep this build where it's at. And because, at the low end, every dollar is far more valuable with regard to where you place it, at the high end, you can do so many different things with that amount of cash that, more often than not, a "jack of all trades" build like this is very easy to criticize. For a hardcore gamer, for instance, you'd probably drop Threadripper and go for a Core i9-9900K; for a streamer, you'd potentially keep it as is, or go for an Intel Core i9-7900X; for a 3D CAD guy, you'd throw out that 2950X, and go for a 2990WX instead, with a lot more memory. Need a high-end server or NAS? Throw out the processor and mobo entirely, and opt for a Ryzen platform, along with a shedload of hard drives. You get the idea.

So, yes, this rig is definitely open to interpretation, and that's the inherent beauty of PC building, after all. For us, though, this is a nice, versatile system—16 cores and 32 threads are still holding strong, and will do so for some time. If the rumors of the Ryzen 3000 series are true, then we may be looking at 16-core versions of that soon enough. However, it still won't come with all of those PCIe lanes, or quad-channel memory. And PCIe 4.0? Well, we currently don't have the tech to even scrape on that just yet, and the hardware that will won't be that dissimilar from the spec here, so you'll still be happy, even two to three years down the line.

For more of our component recommendations, visit www.maximumpc.com/best-of-the-best

INGREDIENTS

PART		PRICE
Case	NZXT H700i	$180
PSU	Corsair RM750x White 750W Gold Certified	$120
Mobo	ASRock X399 Phantom Gaming 6	$250
CPU	AMD Threadripper 2950X	$880
Cooler	Noctua NH-U14S TR4-SP3 Air Tower	$80
GPU	MSI GeForce RTX 2080 Ventus 8G **NEW**	$720
RAM	32GB (4x 8GB) Corsair Vengeance LED DDR4 @ 3,000MT/s	$238
SSD	512GB Samsung 970 Pro M.2 NVMe	$168
HDD	2x 2TB Seagate BarraCuda ST2000DM006	$120
OS	Windows 10 Home 64-bit OEM	$100
Approximate Price:		**$2,856**

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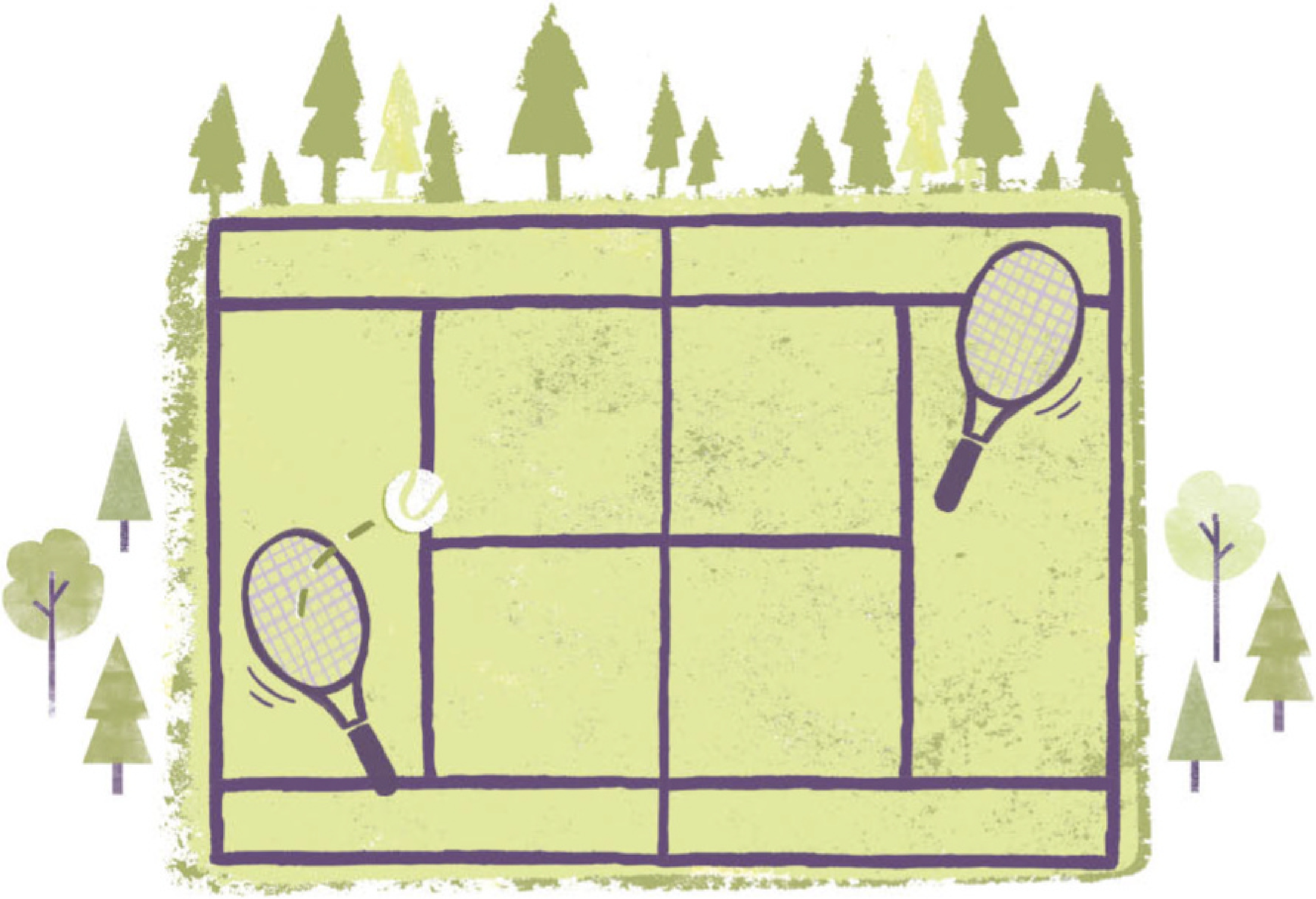

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UNFAO, Global Forest Resources Assessment 2005-2015

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